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US Army Corps of Engineers

PROCEEDINGS
OF THE 53RD MEETING OF THE COASTAL ENGINEERING RESEARCH BOARD

(2)

5-7 June 1990

FORT LAUDERDALE/DANIA, FLORIDA

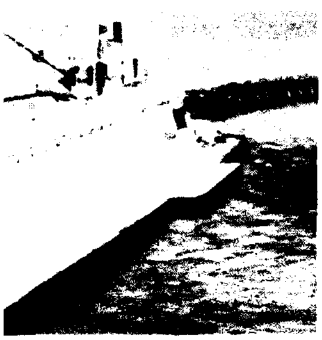
Hosted by

US Army Engineer Division, South Atlantic

and

US Army Engineer District, Jacksonville

Jacksonville District
Team of the Nineties



August 1991

Final Report

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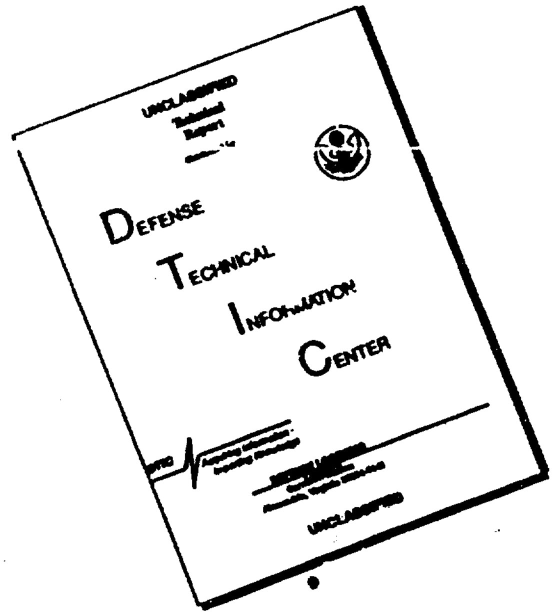

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13. ABSTRACT (*Maximum 200 words*)

These proceedings provide summaries of the papers presented at the semiannual meeting of the Coastal Engineering Research Board (CERB). Also included are discussions of CERB business, recommendations for research and development by CERB members, and public comment.

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PREFACE

The Proceedings of the 53rd Meeting of the Coastal Engineering Research Board (CERB) were prepared for the Office, Chief of Engineers, by the Coastal Engineering Research Center (CERC), of the US Army Engineer Waterways Experiment Station (WES). These proceedings provide a record of the papers presented, the questions and comments in response to them, and the interaction among program participants and the CERB.

The meeting was hosted by the US Army Engineer Division, South Atlantic, under the direction of MG Robert M. Bunker, Commander, and the US Army Engineer District, Jacksonville (SAJ), under the direction of COL Bruce A. Malson, Commander.

Acknowledgments are extended to the following: Mr. Charles F. Stevens, SAJ, who assisted with the coordination of the meeting and field trip; Mr. David V. Schmidt, SAJ, who helped coordinate the field trip; Mses. Cynthia Berrios, Donna Kim Clark-Sims, Louise T. Malanchuk, and Carolyn Mulroe, SAJ, who assisted with various administrative details for the meeting; and Mr. Tirso T. Santana, SAJ, photographer. Thanks are extended to guest participants: Mr. Robert W. Clinger, Palm Beach County, West Palm Beach, Florida; Dr. Robert G. Dean, University of Florida, Gainesville, Florida; and Mr. Kirby G. Green III, Florida Department of Natural Resources, Tallahassee, Florida. Thanks are extended to Mrs. Sharon L. Hanks for coordinating and assisting in setting up the meeting and assembling information for this publication; Dr. Fred E. Camfield for preparing the draft proceedings from the transcript; Ms. Lee T. Byrne and the Information Technology Laboratory for editing these proceedings; and Mrs. Karen R. Wood for typing, all of whom are at WES. Thanks are extended also to Ms. Dale N. Milford, Certi-Comp Court Reporters, Inc., for taking verbatim dictation of the meeting.

The proceedings were reviewed and edited for technical accuracy by Dr. James R. Houston, Chief, CERC, and Mr. Charles C. Calhoun, Jr., Assistant Chief, CERC. COL Larry B. Fulton, Executive Secretary of the Board and Commander and Director, WES, provided additional review.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

PATRICK J. KELLY
Major General, US Army
President, Coastal Engineering Research Board

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INTRODUCTION

The 53rd Meeting of the Coastal Engineering Research Board (CERB) was held at the Fort Lauderdale Airport Hilton in Dania, Florida, on 5-7 June 1990. It was hosted by the US Army Engineer Division, South Atlantic, under the direction of MG Robert M Bunker, Commander, and the US Army Engineer District, Jacksonville, under the direction of COL Bruce A. Malson, Commander.

The Beach Erosion Board (BEB), forerunner of the CERB, was formed by the Corps in 1930 to study beach erosion problems. In 1963, Public Law 88-172 dissolved the BEB by establishing the CERB as an advisory board to the Corps and designating a new organization, the Coastal Engineering Research Center (CERC), as the research arm of the Corps. The CERB functions to review programs relating to coastal engineering research and development and to recommend areas for particular emphasis or suggest new topics for study. The Board's four military and three civilian members officially meet twice a year at a particular coastal Corps District or Division to do the following:

a. Disseminate information of general interest to Corps coastal Districts and Divisions.

b. Obtain reports on coastal engineering projects in the host (local) District or Division; receive requests for research needs.

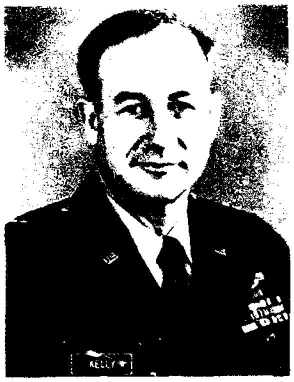
c. Provide an opportunity for state and private institutions and organizations to report on local coastal research needs, coastal studies, and new coastal engineering techniques.

d. Provide a general forum for public inquiry.

e. Provide recommendations for coastal engineering research and development.

Presentations during the 53rd CERB meeting dealt with coastal inlets. Documented in these proceedings are summaries of presentations made at the meeting, discussions which followed these presentations, and recommendations by the Board. A verbatim transcript is on file at CERC, US Army Engineer Waterways Experiment Station.

THE COASTAL ENGINEERING RESEARCH BOARD
JUNE 1990



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53RD COASTAL ENGINEERING RESEARCH BOARD MEETING

Fort Lauderdale, Florida
5-7 June 1990

ATTENDEES

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COL Daniel M. Wilson
Professor Robert A. Dalrymple
Professor Fredric Raichlen
Professor Robert O. Reid

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Ms. Cheryl P. Ulrich, CESAM-PD-FP
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Mr. Charles C. Calhoun, Jr., CEWES-CV-A
Dr. Fred E. Camfield, CEWES-CW
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53RD COASTAL ENGINEERING RESEARCH BOARD MEETING

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Dr. C. Linwood Vincent, CEWES-CP

US MILITARY ACADEMY, WEST POINT

COL William J. Reynolds

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Dr. Robert G. Dean, University of Florida, Gainesville, Florida
Mr. Kirby G. Green III, Florida Department of Natural Resources, Tallahassee, Florida

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Mr. Kenneth Banks, Broward County Environmental Control Board, Fort Lauderdale, Florida
Dr. Kevin Bodge, Olsen Associates, Inc., Jacksonville, Florida
Mr. Thomas J. Campbell, Coastal Planning and Engineering, Boca Raton, Florida
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Mr. Ralph R. Clark, Florida Department of Natural Resources, Tallahassee, Florida
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Mr. Robert F. Denison, Martin County Parks Department, Stuart, Florida
Mr. Barry Douglas, Coastal Technology, Vero Beach, Florida

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Mr. Brian Flynn, Dade County Department of Environmental Resource Management, Miami, Florida
Mr. John B. Green, Genflo, Inc., Franklinton, Louisiana
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Mr. Earl Howard, Coastal Planning and Engineering, Orange Park, Florida
Mr. Albert Hughes, Hillsboro Inlet, Fort Lauderdale, Florida
Mr. Kenneth K. Humiston, Coastal Engineering Consultants, Inc., Naples, Florida
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Mr. Paul Kronfield, Oceanprobe, Inc., Sarasota, Florida
Mr. Richard B. Lombroia, Canaveral Port Authority, Cape Canaveral, Florida
Mr. Martin A. Mets, Port of Palm Beach, Riviera Beach, Florida
Mr. Richard A. Noyes, Martin County Parks Department, Stuart, Florida
Mr. James M. Parks, DYNEQS, Ltd., Tampa, Florida
LT Ralph Petereit, US Coast Guard, Miami, Florida
Mr. Michael Puto, Commissioner, Monroe County, Marathon, Florida
Mr. Robert W. Rodkey, Jr., National Oceanic and Atmospheric Administration, Rockville, Maryland
Mr. Frank J. Rysavy, Hillsboro Inlet, Fort Lauderdale, Florida
Mr. William T. Sadler, Keith and Schnars, P.A., Fort Lauderdale, Florida

ATTENDEES (CONCLUDED)

GUESTS (CONT)

Mr. R. Harvey Sasso, Coastal Technology Corporation, Coral Gables, Florida

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Mr. Stuart Simon, Fine, Jacobson, Schwartz, Nash, Block and England, Miami, Florida

Mr. Steven Somerville, Broward County Environmental Quality Control Board, Fort Lauderdale, Florida

Mr. Stan Tait, Florida Shore and Beach Preservation Association, Tallahassee, Florida

Mr. Aram Terchunian, Coastal Stabilization, Inc., Rockaway, New Jersey

Mr. Art Theriot, Port of Palm Beach, Riviera Beach, Florida

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Dr. Cliff Truitt, Coastal Planning and Engineering, Sarasota, Florida

Dr. Elliot E. Tyler, Special Project Governmental Coordinator, Monroe County, Key Biscayne, Florida

Dr. J. Van De Kreeke, University of Miami, Miami Florida

Mr. Michael P. Walther, Coastal Technology Corporation, Coral Gables, Florida

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53RD MEETING OF THE COASTAL ENGINEERING RESEARCH BOARD
5-7 June 1990
Fort Lauderdale Airport Hilton
Dania, Florida

AGENDA

THEME: Coastal Inlets

MONDAY, 4 June

1830 -	Registration	

TUESDAY, 5 June

0700 - 0800	Registration	
0800 - 0810	Opening Remarks	MG Patrick J. Kelly
0810 - 0820	Welcome to South Atlantic Division	Mr. Kenneth R. Akers, South Atlantic Division
0820 - 0830	Welcome to Jacksonville District	COL Bruce A. Malson
0830 - 0915	Review of CERB Business	COL Larry B. Fulton
0915 - 0935	Interagency Coordination on Hurricane Response	Dr. Albert G. Holler, Jr., South Atlantic Division
0935 - 1000	Expansion of the Field Wave Gaging Program - Plans for SAD	Mr. J. Michael Hemsley, CERC
1000 - 1020	BREAK	
1020 - 1100	Update of Dredging Research Program/Oil Spill Initiative	Mr. E. Clark McNair, Jr., CERC
1100 - 1140	Changing Role of Inlets in Coastal Management	Mr. Charles F. Stevens Jacksonville District
1140 - 1200	Field Trip Overview	Mr. David V. Schmidt, Jacksonville District
1200 - 1300	LUNCH	
1300 - 1315	Board Buses for Field Trip	
1315 - 1800	Field Trip	
1800 - 1845	Free Time	
1845 - 1900	Board Buses for Dinner Cruise	
1900 - 2230	Social Hour and Dinner	

AGENDA (Continued)

WEDNESDAY, 6 June

0800 - 0805	Opening Remarks	MG Patrick J. Ke'ly
0805 - 1005	Panel - Determining Benefits for Coastal Projects	Mr. John G. Housley, HQUSACE - Moderator
0815-0845	Benefits for Coastal Projects	Mr. David V. Schmidt, Jacksonville District
0845-0915	Sand Management: Recommended Modifications in Benefit/ Cost Analysis	Dr. Robert G. Dean, University of Florida
0915-0945	Status Report Update - Economic Evaluation of Corps of Engineers Shore Protection Projects	Mr. William T. Hunt, HQUSACE
0945-1005	Questions from Board	
1005 - 1025	BREAK	
1025 - 1145	Panel - Effects of Tidal Inlets on Shorelines	Dr. James R. Houston, CERC - Moderator
1030-1050	Channel Entrances: Impacts on Coastal Erosion	Dr. Robert G. Dean, University of Florida
1050-1110	Kings Bay Monitoring Study - Lessons on the Impacts of Inlet Stabilization	Ms. Joan Pope, CERC
1110-1130	Nearshore Berms	Mr. T. Neil McLellan, CERC
1130-1150	Questions from Board	
1150 - 1300	LUNCH	
1300 - 1500	Panel - Sand Bypass Systems for Inlets	Mr. Thomas W. Richardson, CERC - Moderator
1305-1325	State of Florida Position on Sand Bypass Systems	Mr. Kirby G. Green III, Director of Beaches and Shores, Florida Department of Natural Resources
1325-1345	Political and Institutional Impacts of Sand Bypass Systems	Mr. Robert W. Clinger, Palm Beach County
1345-1405	Oceanside Experimental Sand Bypass	Mr. David R. Patterson, Los Angeles District
1405-1425	Sand Bypass Plant - Indian River Inlet, Delaware	Mr. Augustus T. Rambo, Philadelphia District

AGENDA (Concluded)

1425-1445	Nerang River, Australia - An Automated, Integral Bypass System	Mr. James E. Clausner, CERC
1445-1500	Questions from Board	
1500 - 1520	BREAK	
1520 - 1550	Coast of Florida Study	Mr. Charles F. Stevens, Jacksonville District
	A Geographic Information System of Coastal Geologic Data for the Coast of Florida Erosion and Storm Effects Study	Dr. Donald K. Stauble, CERC
1550 - 1610	Report on Engineer Manual "Coastal Inlet Hydraulics and Sedimentation"	Ms. Julie D. Rosati, CERC
1610 - 1630	After GITI - The Next Phase of Tidal Inlet Research at CERC	Dr. C. Linwood Vincent, CERC
1630	ADJOURN	

THURSDAY, 7 June

0815 - 0830	Opening Remarks	MG Patrick J. Kelly
0830 - 0900	CERC's New Nearshore Directional Wave Gage	Mr. Gary L. Howell, CERC
0900 - 0930	Scanning Hydrographic Operational Airborne Laser Survey (SHOALS) System	Mr. Jeff Lillycrop, CERC
0930 - 0950	BREAK	
0950 - 1020	Public Comment	
1020 - 1120	Board Recommendations	CERB
1120 - 1130	Closing Remarks	MG Patrick J. Kelly
1130	ADJOURN	

OPENING REMARKS
AND
WELCOME TO SOUTH ATLANTIC DIVISION
AND JACKSONVILLE DISTRICT

COL Daniel M. Wilson opened the 53rd Meeting of the Coastal Engineering Research Board (CERB). He said that he was acting for MG Patrick J. Kelly, President of the Board, who would join the meeting later that morning. He introduced the other members of the Board and welcomed the people attending the meeting. He then turned the floor over to Mr. Kenneth R. Akers of South Atlantic Division (SAD) and COL Bruce A. Malson of Jacksonville District (SAJ).

Mr. Akers welcomed attendees to SAD on behalf of MG Robert M. Bunker, who was unable to be at the meeting. COL Malson welcomed the Board to SAJ. He noted that SAJ has two primary coastal missions: one is to maintain inlets for navigation, and the other is to construct shore protection projects. He said there are eight inlets in the 92 miles of coastline in Dade, Broward, and Palm Beach Counties, Florida; three deepwater ports; and a small craft inlet at Bakers Haulover, all of which are authorized Federal projects maintained by the Corps of Engineers.

There are two sand transfer plants, one at Lake Worth Inlet and one at South Lake Worth Inlet. The plant at South Lake Worth Inlet is the oldest fixed sand bypassing plant in the United States. He noted that the field trip that afternoon would visit South Lake Worth Inlet and also Hillsboro Inlet.

Waterborne transportation is significant in Florida. In 1987 there were 37 million tons of cargo and about 150 different commodities. On the east coast of Florida alone, waterborne transportation accounts for $8 billion of income to the State. Tampa, on the west coast, adds another $3 to $4 billion in revenues. Waterborne transportation is on the increase, as is the population of Florida. In the last 100 years, the population has increased from 370,000 to 13 million people, and waterborne transportation is still a major revenue-producing aspect of the economy.

Originally, there were 9 inlets and two natural passes on the east coast of Florida. From 1920 to 1950, port authorities added an additional 5 inlets; from 1950 to 1989, they added an additional 4 inlets so that now there are 18 inlets, or one for every 20 miles of shoreline.

In addition, there are 152 miles of eroding beaches, of which 61 miles have been renourished as shore protection projects. The State of Florida has cost shared that effort and has contributed $184 million for shoreline restoration. The remaining 91 miles of eroding beaches along Florida's east coast still needs protection, and the State of Florida is quite interested in proceeding with that.

COL Malson said the Corps is looked upon by the Nation to balance sound engineering and sound environmental policies and practices. He thinks we can do that in the coastal engineering arena. Working in partnership with State, local, and other Federal agencies, he is sure we will be able to improve the environment for all those that we serve.

REVIEW OF COASTAL ENGINEERING RESEARCH BOARD BUSINESS

COL Larry B. Fulton, Executive Secretary
Coastal Engineering Research Board
Commander and Director
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

Several action items resulted from the last Board meeting in Redondo Beach, California. The list at Appendix B covers the status of action items from the that meeting and continuing action items from previous Board meetings. All other action items have been completed. We will continue to update the status of action items prior to each meeting and provide a list to the Board as read-ahead material. At the 47th CERB meeting in Corpus Christi, Texas, we were asked to formalize the action item list. A master list showing actions taken since the 47th meeting is maintained at at the Coastal Engineering Research Center (CERC).

Item 52-1 expressed the Board's concerns about restrictions on foreign travel by CERC staff members and on foreign visitors to CERC. Restrictions on foreign travel by our people are a result of various Congressional hearings that were very concerned about foreign travel by the Corps. The Assistant Secretary of the Army has established strict guidelines on foreign travel by our personnel and also on expenditure ceilings that apply to all Corps offices. These guidelines are contrary to AR 70-75, which requires "developing and maintaining reasonable and periodic contact, through personal visits or correspondence, with senior investigators and practitioners engaged in technical work related to its specialized subject areas," and also requires "participating in and/or planning major technical conferences and symposia...." LTG H. J. Hatch and MG Kelly have had extensive discussions on the subject with the Assistant Secretary of the Army; they believe that current policies on foreign travel will not be changed significantly in the foreseeable future and further inquiries may be counterproductive. We will not abandon our efforts, however.

Current regulations of the Department of the Army require all foreign visitors to Corps installations to obtain clearance by submitting a request through their embassies to Army Intelligence at least 45 days in advance of the visit. Regulations relating to foreign visits are summarized in Appendix C. The Corps has met with Department of the Army officials to see if the regulations could be modified for civil works visits. As of yet, we have not been able to convince the Army to reduce the formal requirements. In fact, our ability to work with foreign nationals may become more restrictive. The US Army Engineer Waterways Experiment Station (WES) recently received notice that all contracts involving foreign nationals will now require notification and approval through Army Intelligence. This requirement may cause additional problems, since almost all

universities in the United States have graduate students who are foreign nationals, so we would have to initiate a mechanism to identify when foreign students are working on contracts and obtain permission through Army Intelligence before awarding contracts. WES is currently seeking clarification of the guidance and simplification of the process.

Action Item 52-2 directed us to explore mechanisms for increasing CERC's ability to obtain maximum benefits from foreign research. This is related to requirements of AR 70-75. CERC presently uses several means to stay abreast of developments in other nations ranging from personal contacts between CERC personnel and their foreign counterparts to formalized exchanges of information. CERC has publications exchange agreements with universities and government agencies in 29 countries and receives much of the important information worldwide in coastal engineering. CERC researchers participate in several working groups of the Permanent International Association of Navigation Congresses, serve on the International Wave Model Group developing third generation wave models, and are participants in the International Surface Wave Dynamics Experiment.

Coastal engineering is a sufficiently small field so that we know our peers nationally and internationally and have many informal researcher-to-researcher contacts. CERC has had several informal personnel exchanges and joint programs with foreign researchers over the past few years. These have had to be somewhat one-sided agreements because travel restrictions have prevented us from paying for our personnel to go to other countries to perform research. Examples of informal exchanges have included the experienced Japanese researcher who spent the last year at CERC performing research in an area where the Japanese lead the United States in technology. His salary was paid by the Japanese government. Similarly, over the past few years, CERC has had two Swedish and a Danish researcher in residence at CERC for extended periods of time, and countries such as West Germany and Sweden have paid travel and living expenses for extended visits by CERC researchers to their countries. CERC and Danish researchers are currently each performing equally on a series of laboratory tests in their respective countries, and we are exchanging laboratory data with German researchers. CERC researchers have published joint journal papers with foreign researchers over the past few years as a result of joint research efforts.

We believe informal researcher-to-researcher agreements are best suited to meaningful exchanges. However, this procedure conflicts with Department of the Army regulations, and we have had to curtail some of the informal agreements. Army regulations require that joint research and personnel exchanges be made formally by country-to-country Memorandums of Understanding negotiated and approved through the Department of Defense (DOD). These negotiations must have prior approval by the Department of the Army and have participation by representatives from the legal office

and the US Army Materiel Development and Readiness Command. Most foreign researchers are not interested in the formality of country-to-country negotiations. It also would not seem too fruitful to start country-to-country negotiations through DOD for items such as personnel exchanges when we know travel restrictions limit our travel overseas on exchanges. We have found it easier to work with foreign researchers through contract mechanisms. Contracts with foreign nationals are fairly standard in the Army, and we can award contracts through WES's Broad Agency Announcement mechanism that we use for university contracts. We are also working through the Corps' European liaison, Mr. Jerry C. Comati, stationed in London, to increase our contacts with foreign researchers through contract mechanisms.

CERC now has access to the OMNET/Telenet computer-based international network. Many engineers and scientists at CERC have joined the network, and this should aid in maximizing benefits from foreign research by allowing informal discussions between CERC and international engineers and scientists. The COASTNET computer-based teleconferencing system in the Corps has been very useful in connecting field office and CERC engineers and scientists, and we hope to see similar benefits from the OMNET/Telenet system. This may be an economical advantage as well vis a vis travel costs.

Action Item 52-3 directed us to include a presentation on the Oceanside, California, sand-bypass system at this meeting. That will be addressed by Mr. David R. Patterson of Los Angeles District as part of the Panel on Sand Bypass Systems for Inlets.

Action Item 52-4 is to investigate approaches for including an incentive system to increase CERC publication in refereed journals. AR 70-75 strongly encourages publication in recognized journals. We believe such encouragement to be adequate, and no further direct incentives are needed in this area. Currently, publication of journal papers is an important consideration in promotions to GS-13 to -15 levels at WES. CERC has several journal publications per year from our senior level personnel. We do have a standing agreement with the Journal of Coastal Research to publish a paper per quarter. We do lack journal publications from midlevel personnel, perhaps because these people often do not believe their work is of journal quality. CERC recently implemented a development program for our professionals that will help them stay on track to reach senior levels. One part of this program will involve supervisors and researchers working together to identify yearly progress in publishing journal quality work. We also are starting to add journal publications as milestones in work unit documentation. Some years ago, technical monitors asked that we eliminate journal publications as milestones, but we believe the cycle is now complete and there are no longer such objections, as long as journal milestones are made in conjunction with other milestones that provide more direct technology transfer to field offices.

Action Item 52-5 expressed the Board's concerns that research and development (R&D) expenditures relating to breakwaters, including concrete armor units, have not been commensurate with costs to the Corps in breakwater construction and maintenance. I believe the genesis of the comment was the fact the Board was pleased and excited with progress CERC made on research relating to the Crescent City dolos project and was concerned with lack of funding to further pursue many spinoffs of the Crescent City work.

We agree with the Board's concerns that R&D expenditures in this area have not kept pace with the Corps' breakwater costs, but the same concern applies to many other areas of our Coastal R&D Program. The civilian Board members have now had an opportunity to attend a complete program review since the last Board meeting. They now have an understanding of our funds limitations and our challenges as we try to pursue the many exciting research areas as vigorously as we would like. For example, our budget for the FY91 research program must include the costs targeted to the Field Research Facility (FRF) and for technology transfer. The research devoted to coastal structures is approximately 34 percent of the proposed budget. Guidance from our Headquarters' technical monitors and Field Review Group is that that level of expenditure is appropriate.

Many breakwater expenditures in the Corps today are for repair and rehabilitation. The Corps is initiating a new phase of the Repair, Evaluation, Maintenance, and Rehabilitation (REMR) Program to perform R&D relating to operation and maintenance (O&M) costs in the Corps. CERC has submitted two work units to the new REMR Program that would allow us to further pursue research in concrete armor units and extend this work to a variety of Corps problems. We are hopeful the work units will receive support from a Field Review Group, even though only a portion of the members are from coastal Districts. This program is clearly the most appropriate to fund this research, since most benefits of the research would be to reduce O&M expenditures.

Action Item 52-6 directed us to investigate a Corps program to address catastrophic events. CERC currently has a work unit in the Field Data Collection Program to obtain data during episodic events. Funding for this work unit is not large, but is considered appropriate, given funding constraints. The utility of measurements for episodic events is reduced by the usual lack of baseline information. Currently, the Episodic Events work unit is concentrating on making measurements of beach-fill response at Ocean City, Maryland, where northeaster storms can be expected to produce erosion almost every year. We were fortunate last year to measure erosion during a northeaster with record duration. We also are ready to make measurements during catastrophic events using the resources of this work unit, and CERC responded rapidly to Hurricane Hugo to make a variety of measurements as reported at the last

Board meeting. There were discussions at the last Board meeting of Corps District teams aiding in obtaining measurements for episodic events that are not so severe that District personnel are totally absorbed in emergency operations. We have discussed possibilities with Pacific Ocean Districts and are investigating developing a training program to teach District personnel about making measurements during episodic events.

Action Item 52-7 was to look into sabbaticals for CERC staff to allow them to interact with universities and gain a wider perspective. Since CERC is a reimbursable organization, no mechanism presently exists for internal funding of staff sabbaticals. Through the Intergovernmental Personnel Act program, staff members may go to universities if the university pays all or part of their salary and benefits. WES has just been designated a Demonstration Laboratory under the DOD Laboratory Demonstration Program, which is part of the Defense Management Review. This program is in response to studies conducted by the Defense Science Board that showed that the productivity and effectiveness of DOD laboratories can be significantly improved by implementing specific changes in procedures involving personnel management, contracting, facilities refurbishment, and management authority. The program is new, and we do not fully know all implications, but we are optimistic that we will be able to accomplish many worthwhile endeavors through it. We will pursue the question of sabbaticals with this opportunity.

Action Item 52-8 directed us to investigate a program for foreign nationals (including recently graduated Ph.D's) to work at CERC. The issue of hiring foreign nationals is extremely complex and is tightly controlled by high-level policy and by law. Consequently, changes will have to come from the top levels of DOD, the Office of Personnel Management, and Congress. Perhaps we can gain some support through the Laboratory Demonstration Program, and we will use that avenue to further pursue the matter.

Older items on which action is continuing include:

Action Item 51-5 was to publish John Housley's results from the follow-up studies on low-cost shore protection. That report has been printed and distributed to Board members.

Action Item 51-7 was to determine whether National Oceanic and Atmospheric Administration (NOAA) or the Minerals Management Service (MMS) is mapping coastal sand resources. NOAA is not involved in mapping coastal sand resources, but CERC has discussed the issue with the US Geological Survey (USGS) and the MMS. Discussions to date indicate neither organization is conducting a comprehensive program of coastal sand resource mapping, although USGS is proposing a coastal research program that would focus on erosion, wetlands, polluted sediment, and hard mineral resources. MMS operates in conjunction with interested States to assess

various mineral resources via a series of "Task Forces" composed of representatives from different Department of Interior organizations (MMS, USGS, Fish & Wildlife, etc.) and State agencies, with liaisons from other Federal agencies. There are at present six Task Forces (Alaska, Hawaii, Oregon, Georgia, North Carolina, and Gulf of Mexico), each focusing on different hard mineral resources. The Gulf of Mexico Task Force is the only one concentrating on sand. The Task Forces work mostly with existing data and information to assess topics such as the mineral's extent, worth, recovery feasibility, and potential market, with the overall objective of stimulating the private sector to investigate leasing and developing those resources. Interaction between the Corps and these Task Forces appears to be very limited; and as such, an opportunity would be the mutual benefits that could result from a periodic exchange between the Corps and the MMS regarding information on future needs and activities. Discussions with MMS indicate considerable interest in more dialogue. We believe the Corps should pursue establishing a joint liaison with the MMS Headquarters on subjects related to the delineation and mining of coastal sand resources.

Action Item 51-8 concerned a review of the establishment of a Science and Technology Research Center (STRC). At the last Board meeting, I reported CERC had sent letters to universities involved in coastal research offering to work with any university proposing to develop a multi-university STRC. One university consortium put together a formal proposal to the National Science Foundation for a Center for Coastal Dynamics and Erosion. CERC joined in the proposal as a consortium member. Although the proposal received good reviews, there were only a few STRC's selected, and none of these were in the area of coastal or even civil engineering. Two of the proposal reviewers expressed positive thoughts about CERC's membership in the consortium, but one reviewer was negative on CERC participation because of the thought that basic research conducted by the consortium might be slanted toward practical problems of the Corps of Engineers. Thus, it is not clear that CERC's participation in the consortium helped, since one negative comment carries more weight than two positive comments in this type of competition. CERC is still willing to help any university consortium that would like to propose an STRC.

Action Item 51-9 was to include a discussion on determining coastal project benefits at our present Board meeting. We will have a panel discussion on this tomorrow morning.

Action Item 51-10 was to have Coastal Engineering added to SKAP categories other than R&D (SKAP is the Corps' job referral system for supervisory and some non-supervisory positions). After meeting with representatives of the Headquarters, US Army Corps of Engineers (HQUSACE), Personnel Office and with members of the Career Planning Board, we now agree that adding Coastal Engineering to referral categories

outside R&D could be detrimental to coastal specialists. Because of the complexity of the personnel system, I will not go into detail. More importantly, in our discussions, a broader issue was raised. "Coastal Engineer" is not in the personnel classification system; consequently, the discipline does not officially exist in the Federal Government. There was lively conversation on COASTNET concerning this, with strong feelings that Coastal Engineer should be added as a category since engineering specialty areas such as Hydraulic Engineer and Structural Engineer are presently included. To add Coastal Engineer will require action by the Office of Personnel Management (OPM), and our personnel specialists believe it can be accomplished rather easily. I request the CERB formally recommend the Corps pursue having Coastal Engineer added to the classification system so that our engineers will have the appropriate recognition.

I would be remiss if I did not raise another issue that came from the COASTNET discussion previously mentioned. As noted at other meetings, many of the Corps' coastal specialists are not engineers, but have specialties such as oceanography or geology. There is, at a minimum, the perception by many non-engineers that their careers are hampered by not being engineers. There is a concern that many supervisors and managers consider being an engineer a prerequisite for chiefs' jobs at the branch and section levels, and they are not seriously considered for such positions. Some of the high-level positions in the Corps must be filled by registered professional engineers, but I can cite a number of supervisory positions around the Corps filled by non-engineer coastal specialists. I believe it is important that our managers and supervisors be aware of these perceptions and concerns from some of our outstanding people.

Action Item 50-12 was to explore the potential for sharing with coastal states, the Corps' execution of its coastal R&D responsibilities. HQUSACE Office of Counsel has reviewed a draft cooperative agreement with the State of California for data collection and has returned comments. Comments have been addressed in a revised version that has been forwarded for final approval. The State of California has given verbal approval. The California agreement, once signed, will serve as a model for finalizing discussions now underway with seven other States: Florida, Alaska, Virginia, South Carolina, Hawaii, Louisiana, and Illinois.

On other items of interest ...

I reported at the last Board meeting on our continued progress on the Education Initiative from the Board's meeting in Sausalito, California. To refresh your memory, the Coastal Engineering Education Program is a 1-year program offered by CERC and Texas A&M University through the WES Graduate Institute. Students successfully completing the program will earn a Master of Engineering degree from Texas A&M. The program is becoming known throughout the Corps as "CERC U." We had seven

Corps applicants approved for the first session that will start in August. Planning has proceeded on the course that will be offered at the FRF and the two courses that will be offered at WES during the summer session next year. Dr. Nicholas C. Kraus will teach the Sediment Processes course, and Dr. Steven A. Hughes, the physical modeling course. It is presently planned for Dr. Thomas E. White to teach the course at the FRF. We have had inquiries from individuals outside the Corps of Engineers who are interested in the program, including inquiries from the Egyptian and Korean Governments.

We have had continued progress on the Automated Coastal Engineering Systems (ACES), which has been discussed at previous Board meetings. Version 1.04 was released to the public earlier this year. Version 1.05 has been released to the Corps, and this new version significantly enhances the system's capabilities. It adds graphics capability to the system as well as three new applications: extremal significant wave analysis, Beta-Raleigh Distribution, and combined reflection and diffraction by a vertical wedge. It also adds restricted fetch cases for wind-speed adjustment and wave growth.

I reported at the last Board meeting that the Fisherman's Wharf project was being submitted by San Francisco District for an award under the Chief of Engineers' Design and Environmental Awards Program. Both that project and the Buhne Point, California, shoreline erosion demonstration project were among 29 Corps projects around the world selected for honors. CERC supported the Corps' San Francisco District on both projects. Extensive physical and numerical modelings were used to optimize designs. Both projects received Awards of Merit. The CERC Principal Investigator, Mr. Ray Bottin, received the award for Fisherman's Wharf from LTG Hatch.

In the area of new programs, the Corps will initiate a 3-year, $22 million Wetlands Research Program next fiscal year. CERC has been deeply involved with the planning of this program and will be a major participant. An overview of the program is in Appendix D. Dr. C. Linwood Vincent is a member of the Program Peer Review Group, while Mr. Bruce Ebersole and Ms. Joan Pope were members of the Program Planning Group. Mr. Ebersole has been selected to lead the Critical Processes of Wetlands Task Area. The Wetlands Program is closely coordinated with all of our R&D programs, particularly the Dredging Research Program (DRP). Ms. Carolyn Holmes, Assistant Manager of the DRP, is assisting Mr. Ebersole in planning and implementing the Critical Processes Task Area.

At the 48th meeting of the Board in Savannah in November 1987, we discussed sea level rise and some of the other aspects of climate change, such as potential changes in the frequency of storms. A new R&D program on climate change has just been approved for a 3-year period. CERC will have research efforts directed at the

impact of climate change and sea level rise on coastal structures, and beach and dune systems.

DISCUSSION

COL Wilson asked if the recommendation on adding coastal engineering to the OPM classifications was a recommendation to the Chief of Engineers as the program manager for the engineers and scientists career field and if someone could summarize the comments received from the field. COL Fulton said that the recommendation was to the Chief of Engineers. Mr. Charles C. Calhoun, Jr., said the original question concerned categories on the SKAPs, which turned out not to be a problem. However, in looking at the issue in more detail, it was discovered that coastal engineering does not exist as a specialty. He said it was his understanding that it would be a relatively simple matter to make it a subset under "Civil Engineer" just as "Hydraulic Engineer" is now. No negative results from doing this were found, and the field strongly supports the action.

COL William J. Reynolds noted that some jobs in the Districts and Divisions require registration and asked if there is a separate registration for coastal engineers. Dr. James R. Houston said he was not aware of any state that has such registration. Florida would be the first state, if any state were to do so. There have been efforts to get coastal engineering registration, but they have never succeeded. Registration is a requirement for some top level jobs, but in most positions it is not a requirement. Mr. John H. Lockhart, Jr., noted that most registration is as a civil engineer rather than in a subspecialty. Coastal engineers can be registered as civil engineers, the same as hydraulic engineers are presently registered. On another point, Mr. Lockhart noted that the coastal mission of the Corps was established before the flood-control mission, and he thought it was about time that coastal specialists received recognition. COL Fulton said the recommendation would provide the recognition.

COL Wilson noted the interest expressed by the MMS in participating in some way with the Corps. He suggested inviting the MMS to a future CERB meeting to describe their efforts in the mapping of coastal sand resources and perhaps, from that, allowing a position to evolve that would lead to some sort of cooperation. COL Fulton said if the Board recommended it, they would invite the MMS to a future Board meeting. The Board recommended doing that.

INTERAGENCY COORDINATION ON HURRICANE RESPONSE

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Obtaining and documenting technical data during extreme hydrologic events such as floods and hurricanes are essential to the engineering process. These data seem to become more and more valuable as time goes by. Obtaining flow data during floods now seems to be a routine operation. Normally a team from a nearby technical office can obtain high-water marks and other flood-related data under an appropriate funding source. However, in the case of a widespread disaster, such as Hurricane Hugo, it is not always possible to have a local technical team assess the hydrologic situation because of damage in the local office area. Fortunately, in the case of Hurricane Hugo, others were at hand and willing to obtain the data. However, identifying a source of funds to pay for their efforts was difficult.

The hurricane season on the east coast is from late June to mid-October. The incidence of these storms is greatest in late August and September. Early residents of South Carolina referred to hurricanes as the "September gales." Accounts of these gales go back to September 1686, when a hurricane struck the Charleston area and caused severe destruction to the new colony, but it also benefited the colony by disrupting a Spanish attack near North Edisto Island. Other September hurricanes in that area occurred in 1700, 1713, 1752 (twice), 1787, 1804, 1820, 1822, 1834, and 1989. August hurricanes occurred in the years 1728, 1781, 1813, 1854, 1881, 1885, and 1893. October hurricanes occurred in 1783, 1797, and 1954 (Hurricane Hazel). So over half of these hurricanes from August through October have occurred during the month of September, and only two have occurred during this century.

Hurricane Hugo first appeared as a tropical depression on 14 September 1989. After strengthening and striking the US Virgin Islands and Puerto Rico, it hit Charleston, South Carolina, at midnight on 21 September. Coastal South Carolina, including the city of Charleston, was severely damaged. Many buildings were ruined beyond repair. Thousands of people, including some from the Corps' Charleston District, were homeless and without food, water, or electricity.

While the Federal Emergency Management Agency (FEMA) and others were assisting with the disaster recovery, professionals from CERC were immediately on the scene to make a rapid poststorm assessment of the storm's effects on shore protection works, dune fields, shorelines, beach fills and inlets before natural recovery and human activity changed the poststorm situation. Teams covered the South Carolina coast from

Little River Inlet to Edisto Island in 8 days, documenting their findings with photographs, videotapes, field notes, and beach profile surveys.

As soon as cloud cover permitted, another team from CERC flew south along the coast from Myrtle Beach, South Carolina to the southern end of Edisto Island. Their purpose was to observe beach, dune, and inlet storm damage in areas inaccessible by land, to determine the most effective locations for ground-based measurement and technical assessment of storm damage. The team documented the nature and possible causes of beach and dune damage; they assessed the performance, condition, and possible effects on adjacent shorelines of existing Corps projects; and they evaluated the performance of existing works and present conditions in areas where the Corps has proposed projects.

At the same time, aerial photographs of the South Carolina coast from Little River Inlet to Edisto Island were obtained by an existing CERC photogrammetry contractor. These photographs can be compared with pre-Hugo photographs obtained by the State of South Carolina. The photography is a valuable addition to ground-based information.

While we were very grateful that CERC was available to obtain this very important information, identifying funds to pay CERC for this work became a major effort.

On 2 February 1990, Mr. Andrew Garcia, CERC, visited SAD to present results from the poststorm survey and surge analysis from Hurricane Hugo. Mr. Garcia acknowledged the outstanding cooperative efforts of Mr. Rod Cherry, District Chief, USGS, Columbia, South Carolina, in obtaining postdisaster data. Mr. Akers, Director of Engineering, SAD, was in attendance at Mr. Garcia's briefing and asked questions as to FEMA's role in hurricane data collection and analysis and who should be their action agency. Mr. Garcia carried these questions back to CERC, where it was proposed that they be discussed at the next CERB meeting.

FEMA came into existence at the beginning of the 1980's, the result of a reorganization and consolidation of all agencies with disaster and emergency responsibilities. The agency reports directly to the White House. They have enabling legislation that makes them a prime agency for coordinating all Federal assistance to victims of declared major disasters and emergencies. Coordinating and funding emergency data acquisition for the purpose of situation assessment and to aid in future design efforts are important needs, also. In addition to FEMA, the Corps, the USGS, and the National Ocean Service of NOAA have certain coastal responsibilities, one of which is to assess tide frequencies on the South Carolina coast. Also, private firms, such as Greenhorne and O'Mara, perform technical work for FEMA. The need for hurricane data in coastal studies is essential. The role of FEMA in this process needs to be defined in terms of assignment of action agencies and the funding of their

efforts. Certainly the Corps' coastal engineering capability would make us a prime candidate to be an action agency.

EXPANSION OF THE FIELD WAVE GAGING PROGRAM
PLANS FOR SOUTH ATLANTIC DIVISION

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and
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While the timely collection and reporting of climatological and environmental data have become routine in many countries, a similar capability for waves, currents, and coastal winds has not. The need for long-term, high-quality wave data, in particular, has long frustrated the coastal engineer. In 1974, Professor Robert Wiegel and Dean Morrough P. O'Brien of the University of California at Berkeley commented publicly on the need for information on the nearshore wave climate comparable to data routinely available on many other natural phenomena. Dean O'Brien further expressed his concern for improving the accuracy of wave forecasting and hindcasting techniques through comparison with reliable measurements.

The need for characterizing the nearshore wave climate is much like the experience of conventional meteorological measurement programs. Along coastlines with high population densities, usage of the resource is intense. Ignorance of the processes at work carries a significant penalty. Past programs either have emphasized the collection of deepwater wave climatology or have been too regional or even site specific. With the Field Wave Gaging Program (FWGP), the Corps of Engineers is collecting the long-term, nearshore wave data that are necessary for planning, design, construction, operation, and maintenance of coastal projects, as well as for the verifications of numerical hindcast and forecast models.

The FWGP was born on the west coast, the product of the efforts of Scripps Institution of Oceanography, South Pacific Division, and the Coastal Engineering Research Center. Through the late 1970's, the FWGP grew quickly, expanding along the Pacific coasts of California, Oregon, and Washington and supporting data collection in Hawaii and Alaska. During the 1980's, though, the momentum was lost as funding for the program fell behind what was anticipated. Establishment of the Alaska Coastal Data Collection Program and the transfer of the Florida Coastal Data Network to the FWGP from a research effort was the only significant expansion outside the Pacific basin. In 1988, renewed emphasis was placed on the acquisition of wave data on all

US coastlines. That emphasis was supported with increases in funds, allowing the expansion of the program to actually begin.

Validation of wave propagation and transformation models will be emphasized in future expansion of the network. Existing deepwater National Data Buoy Center buoys will provide pressure and wind fields over the open ocean. Intermediate depth "index" sites will provide directional energy spectra of the incident waves on a region of coastline defined by geomorphic or bathymetric boundaries. Index gages will be maintained indefinitely to allow direct observation of normal and extreme climatic conditions. Within a region, nearshore gages will be deployed for several years to calibrate and verify local refraction, diffraction, sheltering and shoaling models.

Priority will be given to existing and planned Corps projects in siting nearshore gages. A survey of all of the Corps' coastal Districts and Divisions was conducted to identify and evaluate their data needs. The result was a list of 241 sites where data were needed to provide guidance in planning, design, or operation of existing and proposed projects. Selection of gage sites will be based on Division priorities, utility for model input, and technical/logistical constraints. The 5-Year Gage Deployment Plan will be prepared and updated annually.

Presently, data products are procured from sources such as Scripps Institute of Oceanography through contracts. The potential benefit of these products to the general public and the interest from State and local agencies in acquiring them have prompted the Corps to investigate Federal/State cooperative agreements as the more appropriate mechanism. Federal funds, coming through the FWGP, and State funds would be combined to obtain specific data products from regional operators. The operator may be a State agency, a Federal agency, or a private company, depending on the particular task and locality.

The existence of the regional networks has provided a firm foundation for the continued expansion of the FWGP toward its goals, with over 300 gage years of data collected and reported to date. Current projects call for operation of 80 gages around the US coastline, including SAD, within 5 years; however, coordination with other Federal and local needs could bring the total to well over 100.

DISCUSSION

Prof. Robert A. Dalrymple asked what average length of record would be taken at a single gage. He also asked about the form of the Coastal Engineering Data Retrieval System (CEDRS) data format, and what would be on the optical disc for the District offices. Mr. Hemsley said the shortest gage record would be on the order of 3 to 5 years. Offshore, the record is typically quite a bit longer. He said CEDRS would start with wave data from actual gage data, hindcast data from the Wave Information Study (WIS), and Littoral Environment Observation (LEO) observations. The system is

personal computer (PC) based. At some point CERC hopes to have it linked with ACES, and that will require the type of personal computers that ACES requires.

The CEDRS user will have a regional database and will start with a map, like a map of Florida, for his District area. The user can identify the kind of data he is looking for. In the first installment of CEDRS, that will all be wave data. Eventually, there will be bathymetry, possibly sediment data, water levels, and winds. CERC has a list of about 25 different data types that they would like to include. Mr. Hemsley said he thinks that will ensure the survival of CEDRS for quite a while.

The user can select the type of data or the region of interest and will be given on-screen options. The program is very user friendly. For WIS information, the user gets the screens of information that are normally seen in the Sea-State Analysis System. The prototype data are presented in similar format with some statistical presentation. If wanted, time series can also be obtained.

Prof. Fredric Raichlen asked if, in addition to the optical disc, there would also be a periodic hard-copy report, and if so, what that would embody. Mr. Hemsley said nobody has committed to a hard-copy report at this time, but most of the prototype data are available in regular reports from the University of Florida and Scripps. Prof. Raichlen noted that eventually the system would be outside the Scripps and University of Florida domain. Mr. Hemsley responded that there has been discussion of a "coastal data atlas," whether it would be hard copy or electronic media, but there is a plan to have a statistical summary, regularly presented, of the data collected. It will be a few years down the road. The immediate challenge is to get the system working.

Prof. Raichlen said that many times data are collected and archived in some way, and no one really knows where and why and so forth. He suggested that great thought should be given to how data are reported. He also asked how priorities are decided on where to place gages. Mr. Hemsley said CERC went to Division offices and gathered people from each of the Districts. CERC asked for their highest data needs based on past, current, or anticipated project requirements. It was very much Corps oriented. Typically, the Districts found it fairly simple to identify their high-priority needs. The difference between medium and low priority was more difficult.

The cooperative agreements with the State agencies allow us to then expand that and include other areas, not necessarily of Corps interest but of particular State interest and funded by the States. The plan will be expanded to include much more than what is seen on the official Corps plan.

Prof. Robert O. Reid asked how many offshore directional gages exist in the long-range plan. Mr. Hemsley said that through cooperation with NOAA's National Data Buoy Center, there would be a significant number. Mr. A. J. Salem said there were two installed off the southeast coast of Florida, at Hallandale and Palm Beach, that had been in for about a year. Prof. Raichlen asked the depth of water where the nearshore gages were installed. Mr. Hemsley said they try for 10 to 15 meters of water depth. They can go shallower or deeper.

COL Fulton asked for a comparison between the Corps' program and others internationally. Dr. Houston said the Japanese have a very large system; they have operated 80 or 90 gages and have been operating for the last decade.

UPDATE OF DREDGING RESEARCH PROGRAM/OIL SPILL INITIATIVE

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The Dredging Research Program (DRP) is into its third year of activity. The 7-year-long program with a funding level of $35 million has a goal of producing savings in the Corps' dredging budget through more efficient engineering and management practices in dredging operations. That goal is being realized as many user products have already been factored into Corps use. Numerical predictive techniques and plume tracking instruments are helping assure State and Federal resource agencies that dredged material is performing according to approved environmental plans. Berms composed of dredged material with suitable properties are being placed such that beaches are nourished and protected. Rapid means for characterizing sediments at dredging project sites are becoming available. Dredge dragheads specially designed for digging efficiencies also promise to be more environmentally acceptable. A device for accurately estimating water levels in tidally fluctuating areas offshore is providing more precise controls for dredges and survey vessels. Highly accurate three-dimensional positioning systems using Global Positioning System technology are nearing operational stages. Management strategies for aquatic disposal areas, including capping of contaminated sediments, are being applied around the Corps.

The DRP is transferring technology aggressively. Field demonstrations, workshops, video reports, technical notes, personal computer programs and manuals, technical reports, and personal contacts are some vehicles used to bring DRP products to the attention and use of Corps personnel.

The Oil Spill Response Initiative of the Corps of Engineers has as its overall objective "to provide to the Nation important additional means for collecting oil floating on coastal and estuarine waters together with the technical and managerial support needed during major oil spill emergencies." To reach this objective, there are four major thrusts to the initiative. The first is an Engineering Study of hopper dredges to suggest retrofits and hardware modifications that will make this Corps resource more responsive to oil spill emergencies. The second thrust addresses remote sensing capability where the ability to sense and accurately locate spilled oil and discriminate between oil on water and oil on land is needed. Remote sensing work also includes speeding up data processing so that up-to-the-minute maps and charts can be supplied to local managers at the emergency site. The third part deals with developing Corps management strategies that are consistent with Oil Spill Contingency Planning

performed by other agencies, but assures that the Corps' response is timely and appropriate. The fourth part of the initiative deals with authorities, statutory and regulatory directives, constraints and missions, and agreements with others that would facilitate Corps responsiveness to oil spill emergencies.

The Engineering Study of hopper dredges is underway. The US Army Engineer Marine Design Center has begun their evaluation of Corps hopper dredges and will issue a report in approximately 1 year with their recommendations. Other parts to the initiative are currently in the planning and development stages.

DISCUSSION

MG Kelly noted that both subjects are very important, especially the former because of the need to get the maximum efficiency from the resources available to the Corps' dredging program. The whole concept of the DRP started with the Board at their 44th meeting in Sausalito, California, in November 1985. A number of recommendations eventually led to a series of meetings in which the whole program was laid out. It was presented to the administration and Congress, and we are now about halfway through and looking forward to some of the results. He asked what had been transferred, to date, from the laboratory to the field. Mr. McNair said that some of the newer numerical models developed under Area 1 have already been used, including usage in New York, Mobile, the west coast of Florida, and the coast of California. Some of the berm technology is already in use, and some of the bottom-detecting instruments have been used. An equipment program is planned to have a production meter placed on a dredge. Technical guidance documents are being discussed and adopted by some of the Districts.

Prof. Raichlen asked about numerical models that have been confirmed in the field and laboratory studies. Mr. McNair said that data collection is continuing in order to continue the verification process. Some of the models have been used qualitatively to determine if material will move and, if so, which way. They can now be quantified, and that verification process is continuing. The models are more quantitative than they were a year ago, but not as much as they will be a year from now.

Prof. Raichlen asked about dredge positioning and inquired if that technology had not been around in the military and whether the program was taking advantage of that. Mr. McNair said they make some use of the military systems. At present, positioning accuracy is about 10 meters, and better than that under some circumstances. A 10-meter error can be substantial. A navigation channel may extend miles offshore and, to ensure a proper width, can be up to 20 meters too wide on both sides. All that material must be dredged, and the more precise the positioning, the more dredging can be avoided. The same applies to survey vessels. Very accurate dredging surveys are important in determining how much we pay the contractor.

MG Kelly noted that the Corps has 12 dredges in its dredge fleet. The majority of the Corps' dredging activities are done by private industry. As a result of this study, the Corps will come up with some pretty good ideas and use some of the military systems. He noted that there have been some substantial location "busts," with very serious environmental consequences, of a dredge not dredging where it should be or dumping material where it should not be dumping. Jacksonville District has an ongoing court case which is very much related to that effect. There is some work to do, and it is very important that the Corps devotes some attention to that subject.

Prof. Reid asked what percentage of the General Investigations (GI) R&D budget went into oil spills and whether it involved new funding. Mr. McNair said at that point it was a relatively small percentage, but as the work progresses, it will become a

larger portion. The total amount of money is fixed, so it comes at the expense of something else.

COL Wilson asked about the management strategies for the aquatic coastal studies sites and what kind of interaction there is between the DRP and the whole area of monitoring Dredged Activity Monitoring System (DAMOS), recognizing DAMOS is environmentally oriented. Mr. McNair said there is much synergism there, and they exchange information and ideas with the people in New England Division on what they are doing. The DRP intentionally does not do the same thing, but DRP monitoring is a very important aspect of that area. It is good to predict the movement of sediment in advance, but unless we can monitor in an efficient fashion as well and continue to show the resource agencies that we are in fact doing our job correctly, we have not done the complete and total job.

CHANGING ROLE OF INLETS IN COASTAL MANAGEMENT

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ABSTRACT

A century ago, Florida had 11 natural inlets and passes along the 364 miles of ocean shoreline between the Georgia State line and Miami. The State now has 18 inlets along the east coast, the last new inlet being cut in 1948. The creation of new inlets and improvements at the existing inlets were encouraged by the State to increase waterborne traffic, which was virtually the only means of transportation for both freight and passengers. To the extent that inlets aid navigation and commerce, the improvements have been very successful in the economic development of the State. Works to deepen channels or otherwise provide safer conditions for navigation are defined as "improvements" in Federal law. These works also generally resulted in the loss of sand from the littoral system at "improved" inlets. This loss of sand is now of major concern to the State and the residents of the affected coastal counties.

Natural Inlets

In the 1880's, Florida had 11 natural passes and inlets on its east coast. These included Cumberland Sound (St. Marys River), which separates Florida and Georgia; Nassau Sound; the St. Johns River, which was also the outlet for the Fort George River; St. Augustine Inlet; Matanzas Inlet; Ponce de Leon Inlet; Jupiter Inlet; Boca Raton Inlet; and Hillsboro Inlet. The two passes were Bear and Norris Cuts at the south end of Biscayne Bay in Miami. There were no permanent natural inlets within the 154 miles of ocean shoreline between Ponce de Leon Inlet at Daytona Beach and Jupiter Inlet near Palm Beach. An area called Canaveral Bight on the south side of Cape Canaveral was used as an open coast port at that time. In the 1880's only 270,000 people lived in Florida, and 90 percent of this population was classified as rural. The inlets were used to move produce and timber to coastal and international markets.

Improved Inlets

By the turn of the century, the entrance channels to St. Marys and St. Johns Rivers had been stabilized by construction of jetties. Two new inlets had been dredged, one called St. Lucie Inlet, the other called Lake Worth Inlet; however, the latter inlet quickly closed due to natural forces. By 1913, the navigation improvements to Miami Harbor had been completed. Beginning in 1920 and continuing into 1940, local port authorities opened five new inlets along the east coast. These were Palm Beach Harbor (1920), Bakers Haulover (1925), South Lake Worth (1927), Port Everglades (1928), and Fort Pierce (1930). Maintenance dredging at Jupiter Inlet was initiated by the local port authority, and local interests constructed jetties at Boca Raton Inlet. The State population in 1940 was 1.9 million and shifted from predominantly rural to urban.

The Corps of Engineers dredged a cut through the beach north of St. Augustine Inlet to provide a safer passage into St. Augustine Harbor and allowed the natural inlet to close. The Corps stabilized the inlet with two rubble-mound jetties in 1942.

The last new tidal inlet opened on the east coast was Sebastian Inlet in 1948. The last harbor construction on the east coast was at Canaveral Bight, where a non-tidal inlet was created by the use of navigation locks. Maintenance of Hillsboro Inlet was initiated in 1952 by local interests. The jetties at Ponce de Leon Inlet were constructed by the Corps in 1969. Matanzas Inlet and Nassau Sound are the only remaining unimproved natural inlets on the Florida east coast. Norris and Bear Cuts at Miami remain in their natural state.

Conditions Today

The east coast deepwater ports on the east coast of Florida are Fernandina Harbor (St. Marys River), Jacksonville Harbor (St. Johns River), Canaveral Harbor, Palm Beach Harbor (Lake Worth Inlet), Port Everglades, and Miami Harbor (Government Cut). The deepwater ports at Fernandina and Canaveral Harbors are maintained for both defense and commerce. The ever increasing tonnages delivered through the remaining deepwater ports have required continuing improvements for navigation. The depths have increased from 10 feet in 1900 to 42 feet in 1980. Since there is no heavy industry in Florida, the increases in tonnage and channel depths are to service consumer demands of a growing population, which in 1980 was estimated at 9,746,000, and in 1990 is projected to top 12,000,000.

The value of the beach as a revenue resource has increased in proportion to the population. The increasing value of this resource has resulted in the focusing of

attention on the causes of beach erosion. Many of the State's erosion problems have been solved by the more than 60 miles of beaches that have been rebuilt under the Federal Shore Protection Program. State and local interests are now focusing on (1) the effects that inlets are having on the adjacent shorelines, and (2) the disposal of material obtained by maintenance dredging of the inlets in offshore sites outside the littoral drift regime.

The scope of the problem has been brought into perspective, and the individual problems at each inlet are being resolved in many different ways. The only question is who should pay for the mitigation of negative impacts of inlet improvement to adjacent shorelines: the Federal government and local interests who maintain these inlets, the port authorities who have jurisdiction for these harbors, the society that realizes the reduced cost of commodities and energy resulting from the maintenance of these ports, or the tourist industry that profits from the restored beaches? Each in turn points to the other, and in fact all are participating to some extent and in many different ways in the cost of mitigation.

FIELD TRIP OVERVIEW

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ABSTRACT

An overview of the Federal navigation and shore protection projects in the southeast Florida coastal area is presented. The Dade, Broward, and Palm Beach Counties shorelines total about 90 miles and are designated as Region III by the State. This 90 miles of ocean shoreline has a population of over 3.5 million and is projected to increase to 4.7 million people by the year 2000 and double by the year 2020. A 90 miles of shoreline are included in six different authorized shore protection projects. Authorization dates vary from 1958 to 1985. Thirty-six miles of this shoreline have been rebuilt, including 10 miles of hurricane protection in the Miami Beach area. Several portions of the restored beaches have been renourished, some more than once. Twenty-nine miles of the rebuilt beaches were constructed as Federal projects. Since 1970, over 25 million cubic yards of sand has been placed along these shores. Within Region III, there are eight inlets, three of which are maintained by local interests. The remaining inlets are authorized Federal navigation projects, including the major deepwater facility at Port Everglades, and the container and the cruise ship facilities at Miami Harbor. Presently, about $1.2 million per year is spent for the removal of shoal material from the five Federal navigation channels.

PROJECT DESCRIPTIONS

Palm Beach County

The shore protection project from the north Palm Beach county line to Lake Worth Inlet and from South Lake Worth Inlet to the south county line was authorized in 1962. The shore protection project from Lake Worth Inlet to South Lake Worth Inlet was authorized in 1958. These Federal projects in Palm Beach County were authorized for local construction with subsequent Federal reimbursement. Local preconstruction planning is underway for 8.4 miles of shoreline in Palm Beach County as follows: the Coral Cove segment (1.0 miles), Jupiter/Carlin segment (1.2 miles), Midtown segment (2.5 miles), Lake Worth segment (2.1 miles), and Ocean Ridge segment (1.6 miles). About 4.1 of the 44 miles of the county shoreline have been restored. The Boca

Raton project segment (1.45 miles) was completed in 1988. The Delray Beach project segment (2.65 miles) was restored in 1973 and renourished in 1978 and 1984. The 1958 and 1962 projects for Palm Beach County were authorized for construction by local interests, with subsequent reimbursement by the Government.

Jupiter, South Lake Worth, and Boca Raton Inlets are locally maintained. Lake Worth Inlet is maintained as a Federal navigation project. The inlets were first improved in 1922, 1927, 1925, and 1918, respectively, by local interests. The Federal project for Lake Worth Inlet was authorized in 1934. Sand transfer plants were constructed by local interests at both Lake Worth (1958) and South Lake Worth (1936) Inlets. The sand transfer plant at Lake Worth Inlet was part of the authorized shore protection project for Palm Beach Island. Federal participation in this project feature expired in 1968.

Broward County

The shore protection project for Broward County was authorized in 1965. The project provided for initial restoration of about 9 of the 24 miles within the county and future nourishment as needed for the entire county. The Broward County project is authorized for local construction with subsequent Federal reimbursement. About 12 miles of beach have been restored in Broward County since 1970. Pompano (5.21 miles) was initially restored in 1970 and renourished in 1983, and J. U. Lloyd State Park (1.5 miles) was initially restored in 1970 and renourished in 1989. Hollywood and Hallandale (5.25 miles) was initially restored in 1979 and is scheduled to be renourished in the last quarter of calendar year 1990.

Hillsboro Inlet and Port Everglades are the two navigation projects in the county. Port Everglades was initially improved by local interests in 1927. Maintenance of the Port was authorized as a Federal project in 1930. Hillsboro Inlet was initially dredged by local interests in 1952. Navigation improvements in Hillsboro, which included sand transfer, were authorized in combination with the shore protection project in 1965. The Federal navigation features at Hillsboro were never constructed, and the sand transfer system was deauthorized.

Dade County

The Dade County hurricane and storm damage reduction project was authorized in 1968. The project for the Bal Harbor (0.85 miles) was completed by local interests in 1975. The remaining 9.65 miles of the Dade County project was completed under five separate contracts between 1977 and 1982, with placement of 12.3 million cubic yards of material. Several sections of the project have required minor renourishment since 1982. The Dade County North of Haulover project (Sunny Isles 2.46 miles) was authorized in 1985. The initial construction was completed in 1988. The Virginia Key/Key Biscayne project (1.8/1.9 miles) was authorized in 1962. The project was

constructed in 1969. The Virginia Key segment was renourished and 13 groins constructed in 1972. The shore protection project for the remainder of Key Biscayne (2.4 miles) was authorized in August 1985. Construction was completed in 1987. Bakers Haulover Inlet is an artificial inlet constructed by local interests in 1925. Congress authorized jetty reconstruction, channel deepening, and maintenance dredging in 1960 The authorized work was completed in 1964. The Federal navigation project for Miami Harbor (Government Cut) was first authorized in 1902. The initial work was modified several times, and was finally considered complete by 1913. Additional project modifications are included in the proposed 1990 civil works authorization bill.

FIELD TRIP

Site visits were made in the afternoon to the South Lake Worth Inlet Sand Transfer Plant, Delray Beach Segment Shore Protection Project, Pompano Beach Shore Protection Project, Hillsboro Inlet, and Hollywood/Hallandale Shore Protection Project. The first site visited was the South Lake Worth Inlet Sand Transfer Plant. Mr. Schmidt, SAJ, presented a briefing on the inlet, and Mr. John S. Yeend from West Palm Beach, Florida, made a presentation regarding the technical operation of the transfer plant. The tour proceeded to Delray Beach where Mr. Schmidt described the project. At Hillsboro Inlet, Mr. Stevens of SAJ and Mr. Frank J. Rysavy of the Hillsboro Inlet Improvement and Maintenance District presented briefings. Mr. Stevens described the shore protection project at Pompano Beach. The tour concluded at Hallandale Beach. Mr. Stevens described the shore protection project at Hollywood/Hallandale. While on the beach at Hallandale, Mr. Gary L. Howell of CERC presented a briefing on a wave gage deployed off the coast of Hallandale and sample data obtained from the gage.

PANEL
DETERMINING BENEFITS FOR COASTAL PROJECTS

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John G. Housley

Mr. Housley reemphasized the presentation by Mr. Stevens concerning the changing role of inlets in coastal management. He noted that the social and economic impacts on perception of the role of inlets in shoreline management on the Florida east coast has resulted from a change from a rural society depending on waterborne traffic as a lifeline to the outside world, to an urban society depending on tourism but with little knowledge of the importance of waterborne commerce needed to provide the commodities to serve it.

This concern for the Florida east coast today, relating to the adverse impacts of inlets on the saltwater beach resource needed to fuel the tourist industry, is typical of the Nation's eastern seaboard. As evidenced by the number and the variety of authorities and methodologies implemented to mitigate this type of shoreline erosion problem, this national hue and cry for action has not fallen on deaf ears. We have the technology, capability, and expertise to solve the problems caused by inlets.

This leaves only the question of who should pay for mitigation: the Federal government and local interests who maintain these inlets, the port authorities who represent commercial interests profiting from the maintenance of these harbors and inlets, the society that realizes the reduced cost of transportation of goods into and out of the harbors, or the tourist industry that profits from restored beaches.

The degree of interest exhibited by the Federal and State governments in solving the problem at a given inlet increases in inverse proportion to the economic damage being perceived or realized, and in direct proportion to the strength of the economic incentives for action.

BENEFITS FOR COASTAL PROJECTS

David V. Schmidt

Abstract

A method is presented and illustrated with examples to establish reasonable estimates of storm damage reduction benefits, as well as recreation benefits for beach nourishment and navigation projects. While the cost of these projects is well understood and quantified, benefit analysis has in the past varied widely within the Corps of Engineers. The Jacksonville District has developed an empirical computer model to simulate damages for existing conditions and in future years. Existing locations of coastal structures, as well as the location and type of structural improvements, are inventoried. A storm recession versus damage relationship is computed, then converted into a storm probability versus damage function for each year of the period of analysis. The area under the storm probability versus damage curve is then computed for each year of the analysis, and average annual equivalent benefits determined. The model has the flexibility to accommodate predictions on future shoreline position for existing and postproject conditions based on state-of-the-art computer programs such as the N-Line and GENESIS models. The model has the capability to condemn structural improvements after destruction based on local building codes and regulations. The model can be modified as future improvements in storm damage benefit analysis are developed.

Background

Based on the National Shoreline Study, there is about 1,270 miles of ocean/gulf shoreline in Florida. Sandy beaches occur on about 780 miles and about 540 miles are eroding. The erosion is considered critical on about 210 miles. The causes of this erosion include storms, maintained navigation projects, urban development, and rising sea level. There are 151 miles of authorized Federal shore protection projects for Florida's shoreline. The estimated cost to implement the entire program is $400 million. Through Federal and private projects, over 62 miles of shoreline have been rebuilt. Engineering and design are currently underway for construction of another 38.7 miles of shoreline. Since 1968, a total of 45,737,000 cubic yards of sand has been placed within the limits of these projects. The cost of the shore protection projects constructed to date is $184 million. The Federal share of this investment is about $100 million.

The ability of the Corps to make sound investment recommendations to the Congress on shore protection projects is now, more than ever, of utmost importance. The magnitude of the shore protection program and the high Federal cost of these projects, which can now be as high as 65 percent, and increasing Federal budget deficits make accurate benefits essential. The socio-economic and environmental impacts of these projects are of major concern, both within and outside the Corps. In most coastal areas, these Federal projects provide protection against hurricane and storm damage by placement of an artificially enlarged beach. This paper will focus on methods to estimate the benefits associated with providing this type of protection, although the methodology is directly applicable to all shore protection measures.

Benefit Overview

Hurricane and storm damage reduction projects generate both primary and incidental benefits. The primary tangible benefits include physical damages prevented, emergency cost avoidance, prevention of loss of land, land enhancement, and prevention of flood damages. Incidental benefits generated by these type projects include recreation benefits, reducing the cost to navigation projects, and protection to downdrift shores. The Jacksonville District has developed numerical computer models which simulate with and without project benefits. The models can estimate benefits for large-scale shoreline distances, as well as the shorter distances of the typical project. The model can easily perform sensitivity analysis on such parameters as increased rise in ocean levels.

SAND MANAGEMENT: RECOMMENDED MODIFICATION IN BENEFIT/COST ANALYSIS

Dr. Robert G. Dean

INTRODUCTION

With increasing values of and population pressure on the coastline, the demand is becoming greater for proper management of the Nation's limited and valuable high-quality sand resources. To carry out this responsibility, improved methods of accounting for the true benefits and costs associated with sand management practices must be employed.

THE PROBLEM

There are two project types for which improved benefit/cost procedures are recommended: (1) beach nourishment along an uninterrupted shoreline, and (2) sand bypassing at the entrances of navigational channels.

Beach Nourishment on a Straight Beach

When good quality (i.e. coarse) sand is placed along a straight shoreline, a planform anomaly (or bump) is produced which nature tends to straighten out. Waves mobilize the sediment forming this bump, and the sediment spreads out to the adjacent beaches.

This transfer of sand from the project beach to the project-adjacent beaches is often considered an indication of poor project performance. Somewhat surprisingly, it can be shown that if the project-adjacent areas have the same potential benefits (storm protection, recreational, and environmental) from beach widening, the actual total benefits increase, not decrease, due to this spreading out to the adjacent beaches. In particular, the greatest incremental benefits of beach widening occur for the initial widths, and for each additional increment of width, there are decreasing incremental benefits. Thus, when sand is transferred from the project area to project-adjacent areas, the gain in benefits in the project-adjacent areas is greater than the loss of benefits in the project area.

A full accounting of the true economics of a nourishment project would include recognition of the benefits to the adjacent beaches of sand transported from the project area.

Sand Bypassing at Navigational Entrance

Channel entrances constructed or modified for navigational purposes have a great potential to interfere adversely with the natural sediment transport processes with particular erosional impact on the downdrift beaches. The shoreline of Florida and other coastal states is replete with severe and costly examples of this effect.

The interference of navigational projects with natural sediment transport processes incurs a responsibility to reinstate these processes through sand bypassing. Failure to bypass the sediment blocked will result in erosion of an equal volume of sediment from the downdrift shorelines.

In considering the costs of sand transfer facilities to reinstate the natural processes, the costs of loss of storm protection and recreational beaches due to continued induced erosion should be included as a cost of the no-action alternative.

SUMMARY

Although further research will improve our capabilities to address, more definitively, the sediment transport processes associated with beach nourishment and sand transfer (or lack thereof) around navigational entrances, existing knowledge provides an adequate foundation for rational benefit/cost analyses.

STATUS REPORT UPDATE: ECONOMIC EVALUATION OF CORPS OF ENGINEERS SHORE PROTECTION PROJECTS

William T. Hunt

In the fall of 1989, the Corps began development of a procedures manual for economic evaluation of Federal shore protection projects. The ultimate goal of this effort is to arrive at an interdisciplinary arrangement similar to what presently exists for riverine flood-control analysis, in which economists and engineers have adequate knowledge of each others' analytical principles to work as an effective team.

An interim policy guidance document, Engineering Circular EC 1105-2-191, was issued in March 1989. The EC provides general procedural guidance, citing the basic principles of economic evaluation and the relevant physical system factors to be considered for analysis. This relatively short document essentially serves as a skeletal framework for development of the more complete procedures manual.

Two workshops (at Cape May, New Jersey, and Jacksonville, Florida), attended primarily by Corps economists and coastal engineers, have been significantly worthwhile in scoping this effort. An initial draft of the National Economic Development Procedures Manual for Coastal Storm Damage and Erosion was completed in August 1989. A couple of revisions have followed, as a result of thoughtful review and comment from interested economists, coastal engineers, and others from both within and outside of the Corps.

The document is intended mainly for economists and planners involved in economic analysis of Corps projects. It gives a general overview of important principles of economic analysis and planning for Federal projects. It provides a description of the basic coastal processes and coastal engineering evaluation principles and analytical approaches to evaluating storm damages and erosion. It includes descriptions of legal authorities for Corps coastal protection projects, the two major types of projects (coastal storm damage protection and long-term erosion protection), and estimation procedures and techniques for determining project benefits.

The net economic benefits of a project are the measured difference between conditions with and without a coastal shore protection project. Probably the most important part of an economic evaluation of a shore protection project is to establish the conditions expected to exist without a project over the planning period. The estimated storm and erosion effects from physical phenomena such as flooding, undermining, wave impact, and salt spray can then be translated into economic terms. After identifying potential alternative plans designed to result in different coastal condition scenarios over the same period of time, these different conditions can

similarly be translated into their consequences for economic storm and erosion effects. The net effect of each alternative scenario can be reduced to a single net benefit number, allowing convenient comparison of alternatives to aid in selecting a plan.

Two analytical framework methodologies have emerged as potential approaches for economic evaluation of shore protection projects. Both require good models for understanding physical coastal processes.

The expected value approach is the same basic approach used in riverine flood-control evaluation. This approach offers the obvious advantage that it is familiar to Corps analysts. Unfortunately, the analogy between riverine flooding and the coastal situation is less than perfect. It is difficult to sort out the damage effects of different types of coastal processes in the context of this approach. Also, different types of coastal protection schemes provide varying types of protection.

Simulation, using Monte Carlo analytical techniques (designed for dealing with seemingly random events), is the other approach. With this methodology, different potential "futures" can be simulated, or predicted. Each "play" of such a model corresponds to what might happen in real life; averaging the results of several runs of a simulation model is a way of realistically assessing what can be expected over the planning period for a given alternative.

Continued interdisciplinary communication between coastal engineers and economists is a precondition for development of practical working guidance for evaluating Federal shore protection projects. Economics issues that need continuing attention are concerned with the behavior of individuals acting alone and together as communities in response to coastal storm and erosion processes. Coastal processes are complex, and good models to describe these processes are obviously an important element of sound procedural guidance. The evaluation approaches discussed in the draft procedures manual integrate elements of both economic and coastal engineering analyses.

The next step envisioned in this effort to produce a useful planning guidance document is another workshop at which coastal engineers and economists would consider improvements and changes to the manual before it is published for distribution. One of the possibilities for enhancement of this document is to include practical examples and/or case stuuies. The kind of cooperative working effort which has been a major aspect of this project represents the same kind of cooperation which is required for successful individual project planning. This issue deserves to be revisited from time to time to gage the success of developed procedures and to consider modifications for improvement.

DISCUSSION

MG Kelly asked Dr. Dean about the question raised by Mr. Schmidt on benefits to adjacent beaches. Mr. Schmidt had said it appeared the sand had not moved alongshore because the beaches were not accreting. Dr. Dean said it is true that one may not see accretion, but sand moving alongshore may stabilize the adjacent beach so that a beach that was eroding is no longer eroding. Without the project, the adjacent beach may have receded. It is very important to take the background erosion into consideration. Mr. Schmidt said the surveys taken as part of the Coast of Florida Study should give some good answers as to where the sand is moving.

MG Kelly said that Dr. Dean had indicated that there may be more benefits to adjacent areas than to the project area. Mr. Hunt said that a very important pre-condition for the economic analysis is having a good understanding of the physical processes. That involves the interface between the coastal engineer and the economist. If there are effects updrift and downdrift of the project area, then the benefits and costs of those effects would be measured the same as they are for the project area.

Dr. Dean said that we really do not have good monitoring data, and so sometimes we almost have to take a leap in faith and rely on concepts. One concept he felt confident about was that if the sediment is of good quality, it stays within the nearshore system. There have been many misstatements about that in the past. Sometimes, if we cannot definitively show something through very careful measurements, we have to rely on what we find. We do not find the coarser sand offshore. It is not being carried offshore; it is staying within the nearshore system. It is very important to keep in mind the background erosion and the fact that it is being offset by sand moving out from the project area and still providing the same benefits, in fact, more benefits if there is a background erosion. MG Kelly said we have to pursue that.

Prof. Dalrymple asked about the adequacy of bypassing. He asked for Dr. Dean's thoughts on what we are doing, both in Florida and nationally, by bypassing.
Dr. Dean said he thought it was woefully inadequate and that it was unfortunate we have waited until now to set matters straight because everyone has staked out an area. Many factors are involved. The technical problems are probably easier than the social problems. At Sebastian Inlet, the surfers have their area staked out, and the boaters have their concerns. We cannot build a deposition basin inside the inlet. We are going to be faced with a lot of problems other than technical problems. Sand bypassing plants may have to be made so that they do not take up any visible space and do not impede navigation. People are in a tug of war over limited sand resources, and in past cases it turned out that people with the biggest purses won.

MG Kelly referred to the manual for providing guidance to determine National Economic Development benefits for storm damage reduction. He said a time schedule is needed on the final draft and the workshop related to it. He suggested furnishing copies to members of the Board.

Mr. Salem noted that when Congress enacted the law about initial beach fill, they also enacted legislation to permit Federal participation in future nourishment based solely on the fact that the material would move and benefit adjacent shores.

Mr. Robert W. Clinger asked Mr. Schmidt why certain values were doubled in the analysis. Mr. Schmidt said those were to show that different values were not of the same order of magnitude; e.g., the value of the armor did not seem to be the same order of magnitude as the structural improvements, and the same with the recession rate. The model is extremely sensitive to probability versus distance. That indicates that we need to do more work on that predictive tool. MG Kelly asked if that was a sensitivity analysis to show what factors we really need to concentrate on.
Mr. Schmidt said that was correct.

Mr. Stephen Higgins asked Mr. Hunt if he saw, in the future, an evolution of formulas by which the environmental and social impacts would have dollar value both for cost and benefits. Mr. Hunt said that was basically a policy matter There has

been a resistance, in the past, to really bringing those categories of effect into the benefit-cost calculations. In the case of environmental issues, it is hard to break that down and evaluate these effects the same way as other effects. He is not sure at this time where Federal policy is going. Mr. Higgins referred specifically to coral reef damage. Mr. Hunt said the main emphasis has been on the more visible things, like shore protection and damage to businesses, although these other effects are equally real.

MG Kelly said we have not really found a good way to quantify economically environmental and societal considerations to the degree we would like. Nevertheless, this past year LTG Hatch, Chief of Engineers, signed a new policy which states that environmental considerations will receive equal standing with economic and technical considerations. That is going to become more and more important.

Looking at societal considerations with the advent of cost sharing and the Water Resource Development Act, which created the role of the non-Federal sponsor, that role may fall more and more on the local sponsor. The Corps will be looking more toward the non-Federal sponsor to sort out the issues, such as those described by Dr. Dean. The Corps will provide assistance, but will look at the local sponsor to be the arbitrator.

COL Reynolds noted that there are two time scales to be considered: the time scale for nourishment, 5 to 10 years, and the time scale of the record of shoreline recession, which may be 50 to 100 years. He asked how the frequency of events was considered. Mr. Schmidt noted that these are probabilistic predictions of when beach nourishment would be required. We can do a Monte Carlo simulation of storm occurrence based on knowledge of past storm frequency, and if that is done over the period of time of record, we should end up with the same average annual recession through time. Actual beach nourishment is based on erosion that occurs, and it may be at irregular intervals, just as storms are at irregular intervals.

Mr. Schmidt said it is necessary to do a National Economic Development (NED) analysis. That involves determining an optimum beach width that will give the most net benefits in comparison to cost. There may be advance nourishment, overfill, in front of the optimum width, and no benefit is claimed for the advance nourishment. It is very difficult to determine exactly where the beach will be in any given future year, but the idea is to maintain the optimum width, with the advance nourishment or renourishment giving some varying amount of protection in front of that from year to year. The Corps claims benefits only at the project location from the optimum beach width. Dr. Dean has referred to the additional benefits which result from the advance nourishment or renourishment, particularly when the renourishment moves onto shorelines adjacent to the project.

COL Reynolds asked who actually "owns" the sand, once it is placed in the system. Mr. Schmidt said that the State of Florida requires an erosion control line be set at or near the existing mean high-water line. The project fill goes seaward of that line, in essence, on State-owned bottom land. Thus, the sand ownership is in the public domain.

Dr. Kevin Bodge supported Dr. Dean's observation that benefits occur outside the project area. He said his experience in modeling sediment transport has shown that benefits in adjacent areas would be at least 20 to 50 percent of the benefits in the project area. He also noted that recreational benefits should not be neglected. His experience in the Brunswick-St. Simons Island area in Georgia gave recreational benefits of $90 per day per user. Mr. Schmidt noted that the 1986 Water Resource Development Act specified two project purposes: storm damage reduction and recreation. Current administration policy is that we cannot afford to optimize a project based on recreation. It becomes an incidental benefit. The local sponsor has the option of paying the additional cost for recreation benefits.

Mr. Hunt said it is an administration and budget policy, and a cost-sharing issue, that makes the Corps de-emphasize recreation. Prof. Dalrymple pointed out that there is a significant amount of foreign exchange earnings from recreation in places like Florida and Hawaii, and it may be short-sighted not to take that into account.

Prof. Dalrymple asked if we should not be going into two- or three-dimensional coastal models to improve the calculations. Mr. Schmidt said they use the models available, but he agreed that they would like better models. Dr. Houston said that CERC is starting to develop more sophisticated models, but they will not be ready anytime soon. It is part of the coastal R&D program.

PANEL
EFFECTS OF TIDAL INLETS ON SHORELINES

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CHANNEL ENTRANCES: IMPACTS ON COASTAL EROSION

Dr. Robert G. Dean

INTRODUCTION

Channel entrances modified for navigation have a substantial potential to interfere with natural sediment transport processes. The downdrift erosional impact of navigational projects can be extremely severe. Fortunately, through proper sand management, the adverse effects can be greatly reduced. On the east coast of Florida, my assessment is that 85 percent of the erosion is caused by navigational entrances.

EROSIONAL IMPACTS AND THEIR CAUSES

There are several causes of the erosion due to navigational entrances, each of which is discussed briefly below.

Offshore Disposal of Maintenance Dredged Material

Offshore placement of dredged material can result in a complete loss to the nearshore system. Because most navigational channels are deeper than would naturally occur, there is a need to conduct maintenance dredging of these channels. In many cases, this material has been removed by a hopper dredge and placed in deep water. The eventual effect of this practice on the downdrift beaches is chronic erosion due to sand loss and possible increases in wave height due to increasing offshore depths. Over the past decades, on the east coast of Florida alone, there have been approximately 50 million cubic yards of material disposed of by this procedure. Present practices are greatly improved; however, offshore disposal continues at a number of entrances.

Interruption of the Longshore Sediment Transport

Jetties are often constructed at navigational entrances to limit the sediment carried into the entrances and to provide wave sheltering for the transiting vessels. If these jetties are completely sand-tight, they will block the net longshore sediment transport and cause a deposition on the updrift shoreline and an equivalent erosion on the downdrift shoreline. This effect is substantial along Florida's east coast where the annual net longshore sediment transport is on the order of 200,000 cubic yards.

Without effective transfer of the amounts blocked by the jetties, associated erosional effects will progress farther and farther along the downdrift beaches. The effect of this blockage is evident by comparing the updrift and downdrift shoreline changes after jetty construction. In some cases, the changes are greater than 800 feet and may be noticeable for more than 7 miles downdrift.

Modification of Ebb- and Flood-Tidal Shoals

Ebb- and flood-tidal shoals are the sand bodies located seaward and bayward of a channel entrance, respectively. Ebb-tidal shoals in their natural condition can contain many millions of cubic yards of sand. When entrances are modified for navigational purposes, the hydraulic changes induced by the jetties can cause shifting and changes in volumes of the ebb-tidal shoals. A study conducted by Olsen in 1977 documented that 120 million cubic yards of sand was eroded from the nearshore and deposited farther offshore following the jetty construction at St. Marys entrance in the late 1800's.

In the case of new inlets, if no jetties are constructed or if the jetties are low or permeable, much sand can be lost through or over these jetties and stored in the flood-tidal shoals.

Proper Sand Management Alternatives

Perhaps somewhat surprisingly, there is only one appropriate alternative at a navigational entrance on a long shoreline with a substantial net longshore sediment transport. There are no easy or inexpensive fixes. The alternative is to reinstate the natural process through transferring by hydraulic or mechanical means, the net longshore sediment transport around the entrances to an appropriate location on the downdrift beach. Also, the jetties should be of an adequate elevation and sufficiently sand tight to prevent sand losses into the entrance. Other alternatives will result in a continued sand deficient to the adjacent beaches.

It is worthwhile to note that proper sand management is more than a technical problem. It costs money, and shorefront property owners generally participate actively in a "tug-of-war" over limited sand resources. An example of the latter is the sand transfer plan at the Lake Worth entrance, where the politics are such that residents on the updrift side were able to drive a steel sheetpiling cofferdam around the intake so that the sand reaching the transfer plan intake was severely limited. A second example is at South Lake Worth Inlet, where the interests on the updrift side were able to relocate the sand transfer plant 130 feet seaward in 1965.

SUMMARY

One of the most important coastal engineering challenges of the coming decades is to reinstate the natural transport processes at navigational entrances through improved sand management techniques. In addition to designing the facilities to accomplish the transfer, it will be necessary to establish monitoring procedures which can ensure an equitable flow of sand from the updrift to the downdrift sides of the entrance.

Although a more thorough understanding of inlet processes would allow improved designs, present knowledge is considered adequate to begin addressing this particular problem through design and construction.

KINGS BAY MONITORING STUDY: LESSONS ON THE IMPACTS OF INLET STABILIZATION

Joan Pope

St. Marys Inlet, at the border between Florida and Georgia is a Federally maintained entrance channel to the Intercoastal Waterway, ports at Fernandina, Florida, and St. Marys, Georgia, and the US Naval Submarine Base at Kings Bay. In the early 1980's, Kings Bay was selected as the Navy's Homeport for Trident-class submarines. In upgrading the Kings Bay base from the smaller Poseidon-class submarines, it was necessary to deepen and widen the channels through the St. Marys system.

In March 1988, MG C. E. Edgar, Commander of SAD committed the US Army Corps of Engineers (USACE) to perform a 5-year physical monitoring program (FY 1988-1992) at the request of the Navy. The physical monitoring program was designed to address concerns raised by the Department of the Interior and the State of Florida regarding any potential impacts of the increased channel dimensions to the existing coastal and estuarine system at Cumberland Island National Seashore, Cumberland Sound, and Amelia Island. The USACE study elements are the Jacksonville and Savannah Districts (hydrographic and topographic surveys), CERC (coastal studies), and the Hydraulics Laboratory at WES (estuarine studies). SAD conducts the coordination between Corps elements and with the Southern Division of the Naval Facilities Engineering Command. The background and structure of the Kings Bay monitoring Program were reviewed in greater detail last spring at the 51st Meeting of the CERB in Wilmington, North Carolina.

The coastal studies have, as their primary purpose, the identification and quantification of any cause and effect relationships between the channel modification and the ocean shoreline. In order to address this problem, a three-phase study approach was adopted. The study plan includes a review of the natural geologic and process setting and data sets documenting the long-term evolution of the project area (historical substudy), data collection during the 5-year program designed to document any changes, and numerical modeling studies designed to extrapolate the measured process-response to scenarios beyond the measurement period or data resolution.

To date, 2-years of survey, sediment, and wave data have been collected and analyzed, and the wave refraction and shoreline change models have been calibrated and verified. In addition the historical substudy has been completed. For the purposes of this panel presentation, I will be reviewing the major results of the historical analysis and comparing lessons learned from this study to those of other stabilized inlet studies we've conducted along the ebb-tide dominated, barrier island, southeastern coast of the United States of similar configuration jetty systems (i.e.,

Charleston, South Carolina; Murrells Inlet, South Carolina; and Little River, North Carolina/South Carolina).

Murrells Inlet and Little River are two recently constructed shallow-draft navigation projects which have been monitored since construction, providing data on the immediate, postconstruction response. Both projects, built in 1978 and 1983, respectively, include 3/4-mile-long rubble-mound jetties which stabilized a natural inlet and modified the ebb-delta complex. Charleston, South Carolina, and St. Marys Inlet, Georgia/Florida, are two well-established deep-draft navigation projects which reveal much about the "long-term response" associated with major inlet stabilization projects. Large jetty systems (5 miles long at Charleston and 3-1/2 miles long at St. Marys) were constructed in the late 1800's. Quantified geomorphic studies over a 20-to-30-mile section of coast at each site, illustrate the key interactive processes. Comparing such similar, well-documented projects of different scale and age provides a unique opportunity to extend our understanding of the process-response interaction.

These studies demonstrate the structurally induced coastal and offshore response, which in turn illustrates the complex interrelationship of tidal inlets and adjacent coasts. Through these studies, we may develop the scenario where stabilized inlet evolution includes initial thalweg channelization and fillet trapping, a fairly rapid collapse of the natural ebb-delta lobe, and eventual loss of the affiliated ebb-delta platform. It is the loss of this ebb-delta platform that can influence the sediment budget and wave conditions over broad sections of coast. Stabilization of major inlet complexes may trigger a chain of events that can take decades and centuries to fully evolve. The short-term, immediate-to-the-project response of the inlet, shallow-delta lobe, and local shoreline is frequently documented. However, the longer term relationship between the delta complex platform and distant shores has important implications in planning coastal developments and project mitigation. These observations also emphasize the need to improve the economic viability of mitigative practices, such as sand bypassing and nearshore placement of dredged material.

NEARSHORE BERMS

T. Neil McLellan

Introduction

The USACE is responsible for maintaining the navigability of the waterways of the continental United States. A majority of time and money maintaining the waterways is in the form of new and maintenance dredging. The Corps removes 190 to 230 million cubic meters of material annually at an average cost of $400 million per year. The vast majority of this material, over 95 percent, is clean and available for beneficial uses. The Corps has recognized this potential and used dredged material in the past for creation of wetlands, beach nourishment, and habitat development, as well as several other uses including offshore berm construction.

By accurate controlled placement of dredged material, nearshore berms can be constructed to provide physical and/or biological benefits. Benefits include attenuation of wave energy, introduction of material into the littoral system, creation of fish habitat, and cost reduction. The berm must be considered an engineered structure, requiring a verifiable design, construction methodology, and periodic maintenance throughout the design life of the structure. If the berm's primary design purpose is energy attenuation, it can be accomplished by placing material with relief high enough and at such a depth to shoal and break waves, dissipating energy through turbulent diffusion. Since the sediment is not intended to nourish the beach, the construction material is open to a wide range of materials. With proper design and construction, the berm will trip high-energy storm waves, while allowing lower ene: beach building waves to progress onto the beach. The berm's stability will be a function of the sediment grain size, water content, wave climate, structure dimensions, and side slope steepness. Potential benefits derived from this type of placement include shoreline protection by wave attenuation, reusable sediment stockpile, reduction of dredging costs, retention structure for fluid muds, and fisheries habitat. Beach quality material placed within the littoral system can benefit the shoreline by providing additional material for the beach profile. The material can mitigate erosion problems by providing a sacrificial source of sediment, a sill to reduce the movement of material offshore, a source of sand for downdrift areas, and during times of accretion, provide a sand source for the beach profile. The feeder berm erosion rates will depend on wave climate, sediment grain size, depth of placement, and berm dimensions.

Construction

Early attempts at nearshore berm construction were limited by the available dredging equipment. With the advent of shallow-draft split-hulled hopper dredges in the mid- to late-1970's, the feasibility of using conventional dredging and placement practices for berm construction became a reality. The relatively shallow-loaded draft, 6.7 m or less, and rapid placement technique of the split hull, less than 5 minutes, allow the dredge to place material accurately and safely in the active littoral system. Recent Corps projects have been conducted by the Galveston, Mobile, New York, and Wilmington Districts, demonstrating the ability to construct a well-defined nearshore feature with dredged material (McLellan 1990).

Design

To prevent wave focusing and better produce attenuating effects, the berm needs to be constructed as a linear feature and avoid singular conical shapes. Orientation of the berm will be determined by desired intent and local restrictions, but in most cases will be shore-parallel to take advantage of energy reduction benefits.

If the sediment is to enhance the beach profile, it must be placed within the active littoral zone. The most reliable method to determine the active beach profile is by referencing repetitive profile surveys and bathymetry maps at the site or neighboring site that experiences the same wave climate. If adequate profile data do not exist, analytic methods are available (Hallermeier 1981, Birkemeier 1985). Even within the active limit, with increasing depth, there is a diminishing percentage of placed sediment moving in to enhance the beach profile and an increase in the amount of time for the material to move. The optimum depth varies with sediment type, wave period, height, and steepness.

Local wave conditions play a major role in the rate, amount, and direction of movement of material from a nearshore berm. Although it is difficult to obtain site-specific storm and/or wave records, hindcast wave data or model storm simulations are usually available to determine seasonal trends in wave energy and littoral transport direction, as well as conditions for specific storm events. Using recorded or hindcast wave data will aid in not only selection of proper location, but also the appropriate time for placement to avoid seasonal reversals that may move sediments back toward the channel.

To serve as protection for beaches, the mounded material must have above-bottom elevation great enough to selectively filter the waves as they approach. By allowing low-energy waves to pass unhindered, and breaking the large erosive waves, the feature

can provide beach protection. Stability and wave-filtering capability will ultimately be a function of depth of placement, crest elevation, grain size, placement method, deep-water wave height, period, and steepness.

Conclusions

The concept of using suitable dredged material to construct submerged shore-parallel features to derive physical and environmental benefits is gaining acceptance. A properly designed berm can provide benefits by reducing erosive wave energy on the shoreline and/or introducing beach quality material into the profile. Material placed to enhance the beach should be limited to beach quality sands, while stable, wave-filtering berms can be open to a wide range of sediments.

The construction of a nearshore berms has been shown to be an economical form of beneficially using dredged material. Although there are some limitations, the berm concept should be one alternative evaluated when dredged material is designated to be placed along the open coasts. In addition, nearshore placement has the potential of augmenting artificial beach nourishment projects through greater fill stability and reduced costs.

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DISCUSSION

Prof. Dalrymple asked for clarification on whether the material eroded from the nearshore berm went onshore or offshore. Would direct placement on the beach have been more beneficial? Mr. McLellan said it would be more beneficial to the beach to place the material directly on it, but the costs would go up incrementally, so that from a benefit/cost analysis, it might not be better. At Silver Strand in southern California, offshore placement resulted in a widening of the beach. The project at Mobile, Alabama, is being monitored, and there is a movement of material in the onshore direction.

Prof. Raichlen referred to the analogy between sand rights and water rights and noted the State of California had a California Water Plan. Carrying the analogy to sand rights, he wondered if it could become an overall state problem, to look at an

entire state as opposed to individual little local efforts. Dr. Dean said the State of Florida is trying to address that problem. Florida has passed legislation which states that entities responsible for the inlets should place the required amount of sand on the downdrift side, but ports are able to exempt themselves from the legislation. Also, the legislation says "should," which makes it a weak stick. The analogy with water rights does not entirely apply, because the problem with sand is much more localized than it is with water. Dr. Dean thought the legal aspects would evolve.

COL Wilson referred to the suggestion that channel deepening at St. Marys Inlet has had some detrimental effect and asked if there would be a suggestion for some measure of mitigation or correction. Ms. Pope said it would be premature to do that now, but if the final report at the end of the monitoring identifies an impact associated with the deepening, that report would also recommend mitigative action. Periodically, the Corps reviews the monitoring program and interim results with the Navy and Department of Interior and their technical specialists who also provide future direction for the study.

MG Kelly asked why the Fire Island berm did not work. Mr. McLellan said there were some problems with the monitoring surveys, so it was not clear where the material went. The material was very similar to the native beach material, and it was assumed it would stay within the system. There is a very strong longshore transport in that area, and there is a divergent nodal point there, so the material could have gone in either direction. The winter that the material was placed was fairly severe. There is a chronic problem at Gilgo Beach because of the divergent nodal point. MG Kelly said it appeared there was a key question that still needed to be answered.

PANEL
SAND BYPASS SYSTEMS FOR INLETS

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STATE OF FLORIDA POSITION ON SAND BYPASS SYSTEMS

Kirby G. Green III

Sand bypassing plays a role in the State of Florida's policy on inlets. Florida has a total of 66 inlets. It has been estimated that as much as 80 percent of the beach erosion problems on the east coast of Florida can be associated with the way inlets have been maintained and operated along that coast. The restoration of beaches, for the most part downdrift of those inlets, has an annual cost of $40 to $50 million. That is a very significant investment in Florida's beaches.

The State of Florida has begun to take the opinion that we are treating the symptom of a disease, not the disease itself. On the east coast of Florida, that disease is the inlet. The State's policy is that the amount of material available at an inlet, for transport across the inlet, should be transported downdrift. One of the big questions is how to determine the amount of sand available at an inlet for bypassing.

Determination of the bypassing has been handled in two different ways. First, in a cooperative manner with a local inlet district, the State created a Comprehensive Inlet Management Plan. A consultant reviewed the physical nature of the inlet, looked at the effects on the downdrift beaches, the updrift beaches, the inlet, the ebb- and flood-tidal shoals, and then made recommendations on how best to bypass the amount of material available to reduce the erosion rate on the downdrift beach. That worked fairly well and cost about $400,000 to produce the report. Last year the State expended $750,000 on sand bypassing at a non-Federal inlet, which was matched by the inlet district. Expenditures will be about a $1 million every 3 years to bypass sand at that inlet.

A physical model study will be carried out in cooperation with the University of Florida, investigating sand bypassing through jet pump systems or some other alternative. The legislature has funded $100,000 for the initial engineering feasibility for the design of that bypass system.

The second approach is a very heavy-handed, noncooperative approach where, through past studies, the State thought it knew what the bypassing rate should be. The State then ordered the inlet district to bypass that amount of sand. The State of Florida is in litigation over that and will probably be in litigation for a number of years. It is probably a nonproductive method for achieving results that the State wants.

The State, for the most part, is taking the first approach. Five inlet districts have agreed to Comprehensive Inlet Management Plans, and the State is cost-sharing studies

to determine the sand budgets and to determine how to move the sand around the inlets.

One of the State's concerns is that are a number of inlets are Federally authorized, where the Federal government is the operating authority, handling the maintenance of the inlet. The State's inlet management plan may be contrary to the Federally authorized plan. The State of Florida is trying to work with the Corps District so that they can design a study that is consistent with what the Corps would have performed if the Corps were going to do the study. That way, the State can give the study to the Corps, Mobile District in this case, and have them review it, hopefully approve it, send it to Washington for approval, and authorize the types of activities that the State would like to see occur at the inlet.

They had a meeting in May 1990 to discuss the development of shallow-draft dredge equipment which would allow placement of dredged material from inlets at nearshore locations, as feeder beaches or feeder berms. Dr. Dean has shown there is a significant drop in the amount of material coming onshore if material is placed in deeper water. The State of Florida will be pressing the Corps of Engineers to look at modifications to the existing dredge equipment being used in the maintenance of inlets.

The State of Florida will also be asking the Corps to provide, on an annual basis, a quantitative analysis of the amount of material that should be placed nearshore that is now going offshore, i.e., how much sand is being removed from the system. They will ask Mobile and Jacksonville Districts to address that concern. The State has asked for cost studies so that they can cost-share in the placement of that material on the beaches. The State expects to see more and more of the material removed from inlets placed on the beach or in a nearshore area, even if there is an added cost. The State is going to commit the funds for that. It is revenue generated through the tourist industry associated with the beaches. The State cannot afford to lose the tourist industry.

The State of Florida's position is that bypassing must be done to address the problem of beach erosion in Florida. The State is willing to help get it done.

POLITICAL AND INSTITUTIONAL IMPACTS OF SAND BYPASSING SYSTEMS

Robert W. Clinger

There are forty-five barrier island inlets on Florida's gulf coast and twenty-one inlets on the east coast. That does not include river mouths. Palm Beach County has four barrier island inlets. Two inlets, Boca Raton and Jupiter were originally natural, and the other two, Lake Worth and South Lake Worth, were created during the late 1920's. All four inlets have been "improved." Three of the inlets have received State charters and have special taxing district authority and elected commissioners. The fourth inlet, Boca Raton, which was originally privately maintained, was turned over to the City of Boca Raton in 1972, along with a mobile dredge.

Politically and institutionally, many more agencies have a say in what goes on at each of these inlets. Different municipalities are situated to the north and south of each of the inlets. Palm Beach County owns and maintains parks south of Jupiter, South Lake Worth, and Boca Raton Inlets. The county operates and maintains a sand bypassing plant at Lake Worth and South Lake Worth Inlets as well as participating financially in the sand bypass maintenance dredging projects at all of the inlets.

The Federal government maintains the navigation channel at Lake Worth Inlet. The State of Florida owns the bottom land at all of these inlets, and State permits are required at each of the inlets. Each inlet serves different functions: release of floodwaters, water quality, navigation, and commerce. Erosion control is a secondary or nonexistent function.

Although bypassing exists at each of the Palm Beach County inlets, it is performed differently. At Jupiter Inlet, periodic maintenance dredging of the sand trap is performed under contract every year or two; at Boca Raton Inlet, a mobile dredge is used to transfer sand that spills into the inlet across a weir, and the ebb-tidal shoal was dredged in 1988 to supplement their ongoing sand bypassing effort; at Lake Worth Inlet, the county owns and operates a fixed sand transfer plant, and periodic maintenance dredging of the navigation channel is performed by the Corps of Engineers, usually on a yearly basis.

South Lake Worth Inlet constructed a fixed sand transfer plant in 1937 which is still in use and which is the world's oldest sand bypassing plant. The plant was originally constructed privately, but the county assumed responsibility for operation and maintenance shortly thereafter through an informal arrangement. In 1967, a 50-year lease agreement was signed between Palm Beach County and the South Lake Worth Inlet District to continue this effort and to formalize it.

State-wide inlets are under the jurisdiction of either a special taxing district, a county, or a municipality, with the exception of Bob Sykes Cut, which is owned and maintained by the Federal government. At many inlets, ownership is unclear, and maintenance responsibility is shared. There is a hodgepodge of management besides the many regulatory agencies.

Looking at sand bypassing, it has been suggested that 80 percent of the sand lost to the state shoreline can be attributed to inlets. Except for Federal ports, there are only six or seven inlets that have routine or periodic sand bypassing. That is only about 10 percent of the inlets in the state. Four of those are in Palm Beach County. Maintenance dredging by the Federal government for years allowed for offshore dumping of beach quality material. There have been recent changes to that policy, but offshore disposal is still allowed as an option.

In Palm Beach County, there was political pressure placed on the Corps of Engineers to have dredged sand placed on the beach, and that has been done over the last 4 or 5 years. Periodic maintenance dredging, however, requires larger equipment, involves larger placement sites for greater volumes of sand, and may involve the need for greater number of easements, as well as encountering environmental problems and delays. Continuous sand bypassing, or frequent dredging by a mobile dredge, is more acceptable to environmental concerns and may reduce the frequency of periodic inlet maintenance dredging.

There is a divergence of opinion between governments on the updrift side of an inlet, who want to protect their beaches from too much dredging, and governments on the downdrift side, who complain they are not getting enough sand. Fixed sand transfer plants work best when littoral drift is predominantly in one direction. When sand is moving back and forth, so that both sides of the inlet would benefit, it is hard to address that situation with a fixed plant.

Looking first at Lake Worth Inlet, that inlet was constructed between 1918 and 1920. Federally funded maintenance dredging occurred in 1934. The channel was deepened to 35 feet in 1967. Between 1970 and 1978, material from maintenance dredging was placed on the beach or nearshore, but problems occurred between 1978 and 1984, including the lack of easements and lack of State permits, that precluded the placement of sand onshore or nearshore. Since 1984, the material has been placed in a State-permitted nearshore area.

The sand bypassing plant at Lake Worth Inlet was authorized by Public Law 85-500 and began operation in August 1958. It was part of a package which included initial restoration and future nourishments of the beach along Palm Beach Island. To date, only the sand transfer plant has been placed in operation. The Federal government paid 19.3 percent of the cost of the plant and 20.9 percent of the

operating cost over the first 10 years. In August 1968, Federal participation expired. Reports from the Corps concluded that no further Federal support could be authorized, in part due to the inactive beach erosion control project which was not constructed, and in part because the plant produced only a minimum of savings in maintenance dredging. Limited funding was received from the State after 1984.

Other limitations at Lake Worth Inlet included construction of an L-shaped groin north of the inlet which limited the sand reaching the bypassing plant. The groin was later modified by removing sections to either side of the plant intake. Other limitations were the radius of the intake boom and the depth control on the intake.

Operation and ownership are now under the county. There has been no funding assistance except for limited State funds, and the legislature has withheld additional funding for the past 3 years. Recently, a draft plan for Section 111 mitigation has been prepared by the Corps of Engineers. That plan calls for placing material from maintenance dredging on downdrift beaches and replacing the existing plant with a jet pump system. Palm Beach County has agreed to be the local sponsor, but it is felt that the Port Authority should take an active role in the sand bypassing. It will be necessary to obtain easements to relocate the discharge point farther south, and that is not an easy task. The municipality and the land owner to the north are expected to object to the new facility. The county no longer wishes to continue operation of the plant without additional funds. The L-shaped groin needs to be removed, but previous attempts have resulted in legal action, so that issue is still not resolved.

Looking at South Lake Worth Inlet, the plant was originally constructed by private developers south of the inlet in 1937, but was shut down during World War II. The plant was reconstructed in 1967, at which [illegible] moved 130 feet seaward, and a southeasterly shaped hook jetty extension was [illegible] the north jetty. The Florida Department of Natural Resources (DNR) permi[illegible] plant was issued conditionally upon the county operating and maintaining it. [illegible] an attempt was made to add an additional intake pipe 65 feet landward of the plant, halfway between the current location and the original location, but that was opposed by the municipality to the north, and a temporary injunction was imposed. After annual rehearings, the temporary injunction was made permanent in 1984.

An interior sand trap at South Lake Worth Inlet was dredged until 1974. From 1974 to 1989, the sand trap was not dredged, and that accentuated erosion on the downdrift beaches. A suit was filed in 1989 by a downdrift municipality against the South Lake Worth Inlet District and Palm Beach County. The municipality on the north side of the inlet intervened, as did several private property owners on both sides of the inlet. DNR was represented since they had issued an order to the inlet district to replicate the natural littoral drift or face further Department action.

At this juncture there were five political and institutional parties involved in the management of the inlet, all with different points of view, the inlet district insisting that their charter and mission was really water quality. The municipality to the north wanted to limit bypassing because they were afraid of erosion, and the municipality to the south said they needed the sand. DNR said that the inlet district needed to maintain littoral drift, and the county said there was a need for more study and the development of a sand management plan. The county has contracted with a consultant to develop a plan, the intent being to identify the best combination of efforts to address the erosional trends and make use of sand sources that are available.

In conclusion, it is important to understand that inlets have regional and often statewide impacts. Sand bypassing plants help to mitigate and minimize the erosional effects. The South Lake Worth Inlet District has pointed out that they cannot bypass the amount of sand required by DNR because there is insufficient sand being bypassed at Lake Worth Inlet. That is an example of a regional impact.

It would be advisable that inlets be State or regionally controlled. Where possible, regional boundaries should be set so that each inlet is within one political jurisdiction. Too often commission districts or legislative districts use an inlet as a boundary. As a result, one district is pitted against another.

Sand bypassing plants help to mitigate and minimize the erosional effects. Since ocean dredging is an expensive alternative and downdrift communities may even sue for their perceived sand rights, it just may be an economical, cost-effective solution to have an active and efficient sand bypassing operation in place at inlets. There is an old adage, "Either pay me now or pay me later."

OCEANSIDE EXPERIMENTAL SAND BYPASS

David R. Patterson

The purpose of the experiment in Oceanside, California, is to design, install, operate, and monitor a sand bypassing system which is intended to minimize the need for periodic maintenance dredging in Oceanside Harbor. The design objective has been to develop a system capable of intercepting sand that enters the harbor from both the north and south directions of transport and to nourish the eroding downcoast beaches with the material removed from the harbor.

The development of the Oceanside sand bypass project has been approached as an experiment, and its construction has been designed to be completed in stages, thus allowing for sufficient evaluation of each step in the plant's development. Project staging also allows for a thorough monitoring of the physical and environmental impacts brought about by the bypassing process. Data collected during the operational periods of each phase are used to assess the efficiency of operation and are incorporated into the refinement of subsequent designs.

The first phase of construction, referred to as the "Development Plan," was begun in 1985 and represents the foundation upon which the sand bypass experiment is built. It consists of four operational components: the entrance channel jet pump system, the north fillet jet pump system, a mobile (barge-mounted) pumping plant, and a discharge pipeline network (Figure 1).

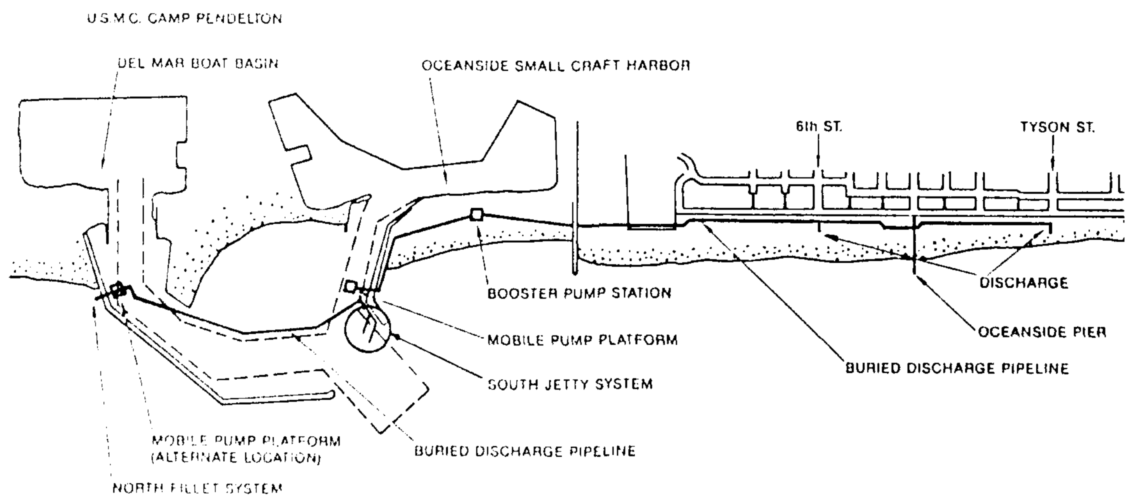

Figure 1. Discharge pipeline network

After considerable delay during construction, this phase became operational in June of 1989 at a cost of slightly over $6 million.

This first phase of the bypass system has operated for almost a year with encouraging results. It has proven to function to its capabilities and, at times, beyond expectations. The Pekor-type jet pumps have operated successfully with limited clogging at both the north fillet and entrance channel pumping locations. The existing plant is capable of removing up to 250 cubic yards of material an hour; however, due to the variability of sand supply to the jet pumps, the average production rate has been closer to 100 cubic yards per hour. The major restriction which limits the amount of sand pumped by the existing plant is the fact that the position of the jet pumps are fixed and, once a crater is formed around a jet pump and the sand is removed from the crater, time must be allowed for the waves and longshore currents to refill the crater with sand in order to resume pumping. This limitation should be reduced by adding fluidizers to the system in Phase 2.

The next phase of the experiment's development is scheduled for construction in the fall of 1990. Two fluidizer lines will be installed in the entrance channel, designed to supply sand to the two jet pumps. These fluidizers are basically inclined pipes which terminate at the jet pumps with holes along the sides to allow pumped water to escape and liquify the surrounding overburden. This "fluidized" sand is then free to flow toward the jet pump crater. Whereas, the existing plant can presently maintain approximately 5,000 square feet of channel area to project depth, the fluidizers should be able to maintain more than 10 times that amount.

In conducting the experiment, the Corps has and will continue to monitor the physical and environmental impacts brought on by the bypassing process. Biological monitoring, which began with the collection of baseline data on shoreline processes in 1984, involves studying the system's effects on fish, plankton, and marine habitats. Physical monitoring encompasses semiannual beach profiles to a depth of -35 feet mean lower low water (MLLW), harbor surveys, wave measurements, and sand sample analyses. Performance monitoring of the sand bypass system relies on a computer-based Supervisory Control and Data Acquisition System (called "SCADA") to monitor and regulate every facet of the bypass operation including pump and engine speeds, pressures, valve operations, and production rates. Over 160 sensor values are sampled every 8 seconds, recorded, and displayed.

The major benefit of the sand bypass project in Oceanside is the opportunity for scientists and engineers to develop and try new ideas which advance the sand bypassing technology. The experimental nature of the project allows for innovative thought and a "proving ground" to test the applicability of the designs. Sand bypassing has a number of advantages over conventional dredging. By emulating the

continual flow of sand provided by nature, many experts believe that the bypass will be more effective in stabilizing the beach than periodic dredging (which creates a large "bulge" of sand that is subject to accelerated erosion). More importantly, by avoiding the costly mobilization costs required by conventional dredges and by using the relatively efficient jet pumps, the bypass has the potential for significant savings over conventional dredging.

SAND BYPASS PLANT
INDIAN RIVER INLET, DELAWARE

Augustus T. Rambo

Indian River Inlet, Delaware, is located on the Atlantic Coast of Delaware approximately 10 miles north of Ocean City, Maryland. The 500-foot-wide inlet is stabilized by two parallel, rubble-mound jetties. Since the inlet's construction in 1938-1940, erosion related to the jetties has occurred on the beach north of the inlet. To mitigate beach erosion which threatens a state highway (Route 1) north of the inlet, a fixed plant sand bypassing system using eductors (jet pumps) was constructed adjacent to the south jetty. Cost of the system is being shared with the State of Delaware, which will also operate and maintain the system. Construction of the system was completed in January 1990 at a cost of $1.6 million.

Background

The inlet in its present configuration forms a near total barrier to the net northward transport of littoral sediment. Net northerly longshore transport has resulted in a sizeable accretion fillet adjacent to the south jetty that has been in approximate equilibrium for 20 to 30 years. Material that bypasses the south fillet is now trapped in flood- and ebb-tidal shoals rather than continuing onto the beach north of the inlet. The approach which has been applied from 1957 to 1984 has been to offset the beach erosion through periodic placement of beach fill along a zone extending as much as 5,000 lineal feet north of the north jetty at Indian River Inlet. A total of 3.4 million cubic yards of sand has been placed on the north beach from borrow sources within the back bay and the flood shoal.

The determinat.on of longshore transport rates at Indian River Inlet was based on analyses of both the wave climate and the post-1940 morphological changes of the vicinity. The analysis of wave climate was based on data from the Atlantic Coast Wave Information Study (ACWIS) performed by WES, Vicksburg, Mississippi. The long-term net longshore transport rate at Indian River Inlet was determined to be approximately 110,000 cubic yards per year to the north.

The nourishment requirement for the north beach was determined to be about 100,000 cubic yards per year. The computed annual nourishment quantity for the highway protection is thus within the range of the average annual net sediment transport quantities determined to pass through, and therefore be available from, the south jetty fillet area.

Design

The sand bypass system was designed to deliver 200 cubic yards of sand to the north beach per hour of pumping. The 200 cubic yards was based on the 100,000 cubic yards per year of beach nourishment required and the estimated available time during the year that pumping could be accomplished.

During the design, it was determined that the eductor(s) must be able to reach a relatively wide zone to accommodate natural and induced beach profile fluctuations within the fillet area and not be adversely affected by such problems as debris, severe weather, and the recreational needs of the public using the beach.

The method selected for deployment of the eductor was to use a large crawler crane located on the beach. The eductor is attached to the crane's lift cable and raised and lowered in and out of the sand. The use of a crawler crane has a number of advantages. The boom length and lifting capacity are suitable to allow the eductor to be placed from mean low water and above; the boom is long enough to keep the crane away from the crater side slopes; the eductor can readily and easily be moved to another location if debris clogging becomes a problem or if sand is not flowing to the eductor as needed to suit pumping rates; and during the summer season, the crane, eductor, and piping can be removed from the south beach so as not to adversely impact the recreation areas or create a safety concern as would a permanent structure.

System Details

The sand bypass plant consists of a permanent 28- by 44-foot pump house located adjacent to the south jetty to enclose the necessary pumps and equipment and a small control room for the operator. The two pumps, the supply water pump, and the slurry booster pump are driven by 8- and 12-cylinder diesel engines, respectively. The system draws clear water from the inlet, and supplies flow to the eductor with a centrifugal supply water pump operating at 2,500 gallons per minute (gpm) at 150 pounds per square inch (psi) through a 10-inch inside diameter (ID) high density polyethylene (HDPE) supply line. The eductor has a 2.5-inch nozzle and a 6-inch mixing chamber. A crawler crane rated at 135 tons with a 120-foot-long boom is used to deploy the eductor. Discharge from the eductor is through an 11-inch ID HDPE line to a slurry booster pump operating at 3,500 gpm at 70 psi. The discharge line is HDPE, which crosses the inlet via the Route 1 bridge. The discharge line extends up to a maximum length of 1,500 feet on the beach north of the inlet. Along the north beach, the discharge pipeline can be shortened or extended for discharge at any point.

The sand slurry flow is monitored using a nuclear density meter and doppler flowmeter, and the supply water flow is monitored by an ultrasonic-type flowmeter suitable for use with nonslurry flows. Both meters are located on the pipeline within the pump house.

The eductor can be positioned up to 500 feet from the pump house to include an area 400 feet along the beach and extend out beyond the mean low waterline. One eductor is deployed along the south beach at any given time, since the maneuverability of the crawler crane precludes deployment of additional eductors.

The system is not a remote-type operation, and a computer operating and monitoring system is not provided. The diesel engines start-up and shutdown and clutch engagement and disengagement to operate the pumps are done manually. However, remote readout for the various pressure gages on the pipelines and the two flowmeters are located in the control room, and a remote readout of the density meter is located inside the crane cab. The flowmeters record flow rate in gallons per minute, density of the discharge flow in cubic yards per hour (cy/hr) and percent solids, and total cubic yards discharged.

Performance

The plant began bypassing sand to the north beach 30 January 1990. As of 23 April 1990, the plant has discharged to the north beach 40,340 cubic yards. Based on the 175 hours of pump running time, the average overall pumping rate is 230 cy/hr. This rate exceeds the initial design rate of 200 cy/hr. A peak rate of 415 cy/hr was reached during a 2-3/4-hour period when the system pumped 1,140 cubic yards. The plant is operated 4 days a week, 10 hours Monday through Wednesday, and 7-1/2 hours on Thursday. The pumps have operated for as little as 1 hour to as much as 10 hours per day. There have been two extended shutdowns, 3-1/2 weeks in March to correct a problem with the crane and 1 week in April to allow the fillet area to accrete before continuing bypassing.

The Indian River Inlet Sand Bypass System is a simple, basic design, using conventional and readily available pumps and equipment to mine sand from the updrift fillet area to nourish the beach on the downdrift side of the inlet. Although in operation only 4 months, the plant has performed better than designed. However, the plant began operating during the season when longshore transport is predominately in a southerly direction, and the south fillet has experienced noticeable recession. As the seasons change and the drift is reversed, the fillet is expected to rebuild.

NERANG RIVER, AUSTRALIA
AN AUTOMATED INTEGRAL BYPASS SYSTEM

James E. Clausner

Introduction

The Gold Coast section of Queensland is located along the mideast coast of Australia (Figure 1). Blessed with a nearly tropical climate, it is one of Australia's main tourist centers. The Nerang River Estuary flows through the area along a shallow estuary known as the Broadwater. Although the area has long been known for its fine beaches, boating, and fishing, local interests felt that further development was hampered by lack of safe passage to the Pacific Ocean. The existing Nerang River Entrance was extremely treacherous due to a very large shallow ebb-tidal bar. The entrance, which had migrated north at an average of over 120 feet per year through this century due to a strong northerly sediment transport, required stabilization to create a safe channel. However, the effort and expense of a stabilized entrance would be wasted without sand bypassing because littoral drift would quickly fill the area next to the south jetty and bypass it, creating a new bar across the entrance and causing erosion on South Stradbroke Island.

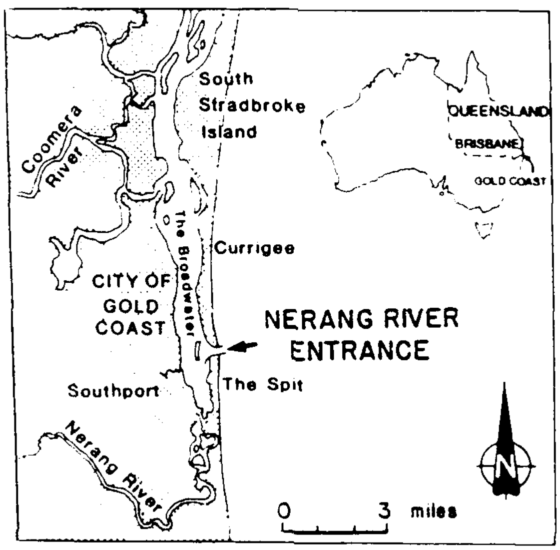

Figure 1. Nerang River Entrance location map

To stabilize the Nerang River entrance, local interests decided to constrain the channel with jetties. Plans for sand bypassing were included from the start, making the Nerang System perhaps the only bypassing system in the world designed and constructed as an integral part of a major inlet stabilization project. Based on extensive physical and numerical studies, design of the project was completed in 1983. Construction of the jetties and dredging of the new channel were completed by November 1985. Sand bypassing system trials were completed, and the system started operations in June 1986. A more complete description of the project as a whole is provided by Coughlan and Robinson (1990).

This section of the Australian coast has a moderately active wave climate, similar to the southern California coast of the United States. Longshore transport for the area is almost unidirectional, with the average net transport estimated at 650,000 cubic yards per year to the north (Figure 2), the design annual bypassing rate.

Several different bypassing schemes were initially considered. A trestle-mounted jet pump system was ultimately selected. Discussions of the alternatives and selection process can be found in Clausner (1988).

The primary goal of the bypass system at Nerang is to prevent shoaling of the entrance channel. It is designed to intercept most of the northerly longshore sediment transport. Some storage in the south jetty fillet is needed during large storms. To intercept and bypass this large amount of sediment transport, the project uses a shore-normal trestle over 1,600 feet long with 10 jet pumps spaced every 100 feet over the outer end (Figure 2).

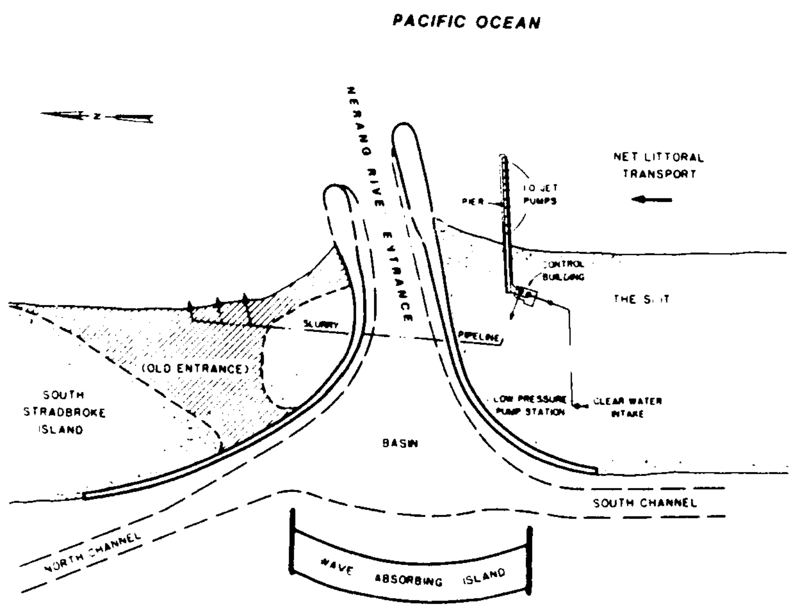

Figure 2. Nerang River Entrance Bypass System, plan view

Bypass System Design

The design bypassing rate for the system was based on calculated cyclone transport rates demanding a system transfer rate of 750 cy/hr. Since this high rate would probably seldom be needed, the system was designed to operate at a normal bypassing rate of 435 cy/hr, approximately 60 percent of maximum. The final design of the system is shown in Figure 3. Each individual jet pump is a 3-1/2-inch Genflo "Sand Bug" jet pump, rated at 135 cy/hr. Detailed system and hydraulic designs are provided by Clausner (1988). An unusual feature is a conical buffering hopper just before the slurry pump. It allows the incoming slurry to vary considerably in solids content and still allow use of a conventional booster pump which transfers the slurry across the entrance to be automatically controlled. Slurry is removed from the hopper and transferred across the inlet by a 950-horsepower variable-speed dredge pump.

The discharge line is a 16-inch-diameter steel pipe with a polyurethane lining. Total length of the discharge line is 3,870 feet, with the most distant of the three discharge points on South Stradbroke Island 1,710 feet from the north jetty.

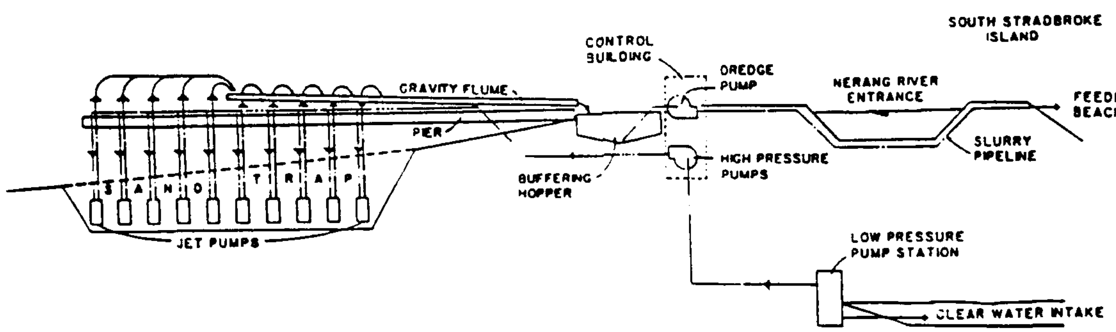

Figure 3. Nerang River Entrance Bypass System, elevation view

Bypassing Operations

The Nerang River Entrance Bypass System has a number of unusual features associated with its operation. The bypassing system is operated by employees of the Gold Coast Waterways Authority (GCWA). Three full-time employees are onsite 40 hours per week, from approximately 7:30 AM to 4:00 PM. During the day, they perform maintenance operations, remove debris from the craters, and adjust discharge pipe locations. Prior to leaving, the operators check the level of sand in the jet pump

craters with a lead line and program the sequence of jet pumps to be operated that night by the computer. Electricity rates in Australia are $0.15 per kilowatt hour (kWh) during the day, but fall to $0.05/kWh from 9:00 PM to 6:00 AM. Obviously, it is much less expensive to operate the plant, which is totally electric, during the low-cost hours. This is possible because (1) the plant has been designed for automated operation by computer and (2) the discharge site, South Stradbroke Island, is uninhabited. Consequently, there are no safety problems on the downdrift beach associated with the unattended bypassing operation.

System Performance

During the first 3-1/2 years of operations, the system has met most design standards, including the most important one of preventing inlet shoaling. Bypassing performance is summarized in Table 1. Maximum measured output from a single jet pump has been 140 cy/hr. The higher monthly rate over 1986 was due to an abundant supply of relatively debris free sand (1,300,000 cubic yards) that accreted against the south jetty prior to the start of the bypassing system. During 1987 and 1988, debris problems kept the bypassing rate just slightly below design levels. During 1989, heavy rain in the area caused the creeks and rivers south of the Nerang to discharge larger than normal amounts of debris, particularly timber. This debris migrated into the jet pump craters (Coughlan and Robinson 1990). Wave activity during the year also eroded dune grasses which formed large masses that effectively prevented sand from reaching the jet pumps. The overall result was a lower bypassing rate during 1989.

Table 1
Summary of Bypassing Performance

Time Period Year	Average/Week cy	Average/Month cy	Yearly/Total cy
1986 (Jun to Dec)	22,000	95,000	570,000
1987	12,000	53,000	640,000
1988	11,000	49,000	590,000
1989	8,400	36,000	440,000
		Total	2,240,000

As might be expected, the nearshore jet pumps have bypassed considerably more sand than the offshore jet pumps. On the average, the nearshore pumps have over 100 percent more operating hours than pumps farther offshore.

The amount of energy required to date has been significantly higher than predicted due to debris reducing jet pump performance. The system was designed to require only 2.4 kWh of electricity per cubic yards of sand bypassed. In fact, the kilowatt hours of electricity per cubic yard have been: 3.0, 3.4, 3.7, and 4.7, respectively for 1986, 1987, 1988, and 1989. Annual operating costs are shown in Table 2.

Table 2

Nerang Annual Operating Costs

($Australian)

Item	1987	1988	1989
Electricity	$198,603	$161,092	$ 82,792
Salaries, Wages and Associated Costs	53,031	57,492	76,856
Repairs and Maintenance	37,632	88,267	103,485
Totals	$289,266	$306,851	$363,133
Cost Per Cubic Yard Bypassed	0.45	0.52	0.83

The operating costs are in Australian dollars, which are roughly comparable to US dollars. These costs do not include amortization of the $7.2 million plant over the life of the project or replacement of the major components. When these costs are included and assuming a 30-year plant life and 9-percent interest, the cost per cubic yard increases to about $2.10.

The bypass system has had a positive impact on the surrounding shoreline and entrance channel bar. Updrift of the jetties, the shoreline has returned to approximately the preproject location. There is a slight indentation at the pier and a small accretion fillet adjacent to the south jetty. The downdrift shoreline has actually accreted due to onshore migration of the old ebb-tidal bar. A new ebb-tidal bar has formed seaward of the inlet. However, the bypassing operation has minimized bar volume and height, keeping the bar height below the channel depth of 16 feet. To date, no dredging has been required or is planned.

Problems and Solutions

By far the biggest problem has been debris in the jet pump craters, reducing performance. Virtually any item entering the littoral system (rocks, bricks, wood, trash) tends to find its way to the bottom of the craters. Eventually, this debris restricts the flow of sand enough to reduce the bypassing ability from the system average of 400 cy/hr to less than 250 cy/hr.

Actual clogging of the jet pump is caused primarily by timber pieces from nearby rivers. This, along with nozzle replacement, requires periodic hiring of a 20-ton crane to remove jet pumps for servicing. The GCWA has tried several solutions to the debris problem. The most successful has been a "clean-out" jet pump, with a mixing chamber opening of 10 inches as opposed to the 3.5-inch opening on the normal jet pumps. It was able to bypass a significant amount of larger debris. Increased wave activity during 1988 and early 1989 has increased the debris problem to such an extent that the GCWA is now planning to install the 10-inch jet pumps in place of the 3.5-inch pumps at each of the 10 locations along the pier when funds become available. Since these larger pumps require the entire output from the supply pump, they are operated individually.

Summary

During its 4 years of operation, the bypass system at the Nerang River Entrance has successfully achieved its purpose of keeping the inlet channel open. While the extent of the debris problem was not anticipated, the GCWA has been able to bypass sufficient amounts of sand to keep the channel open and prevent significant shoreline impacts. Indications are that after the larger jet pumps are installed, future debris problems should be reduced. Including the bypass system in the construction of the improved inlet has prevented most of the negative impacts associated with inlet stabilization.

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DISCUSSION

Prof. Dalrymple said he was pleased to see the successful Indian River Inlet bypass plant. He did point out that modification to the inlet, by bypassing or otherwise, changes the littoral regime and the location of the ebb- and flood-tidal shoals. He said it would be necessary to look at the future fate of the highway bridge over the inlet because the bypassing removes a source of sediment supply to the inlet. The inlet may deepen, which it has been doing historically, and undermine the bridge which already has a scour problem. We need to forecast ahead of time to determine any adverse effects from the project.

Prof. Raichlen asked how the Australians have prevented undermining their own structure, since they are using fixed jet pumps, and if they are planning to install trash racks. Mr. Clausner said the piles that support the pier go down quite deep, and there is about another 30 feet of piling below the bottom of the jet pump's excavation. They also have additional piles between the jet pumps. They have tried many things to control debris. They did not think trash racks would be practical, but that the clean-out pump or the larger diameter pump, along with occasional use of divers, would handle their problems.

MG Kelly asked about the operating costs of the plants at Indian River and Oceanside. Mr. Rambo said it would depend somewhat on how well the system at Indian River operates. They would have a better estimate in a couple of years when they have some operating experience. Right now, the initial estimate is $300,000 per year for 100,000 cubic yards of bypassing. Mr. Patterson said the initial operation at Oceanside, the Phase I plan, was not designed to be an operational plant. There would be a lot of debugging while they try different things. The cost could be something like $10 per cubic yard. Phase I is only the foundation upon which we will build an operational plant.

MG Kelly said that as the Corps investigates the different sand bypassing systems, we need to see how the operating costs compare. He noted that both the Nerang River and Indian River plants have a continuous attachment of the fluidizer to the jet pump. He asked if that was being considered at Oceanside for the Phase II design. Mr. Patterson said it had been considered, but they were limited in construction costs, so the option was dropped. He said the jet pumps being used tended to fluidize the sand around the jet pump and feed it directly, whereas the long seabed fluidizers will expand the operating area of the jet pump, by a factor of 10 once they are in place.

Mr. Clausner said the other two systems cannot be directly compared with Oceanside. At the Nerang River site, the pier extends into the active surf zone, so wave action is moving the sediment. At Indian River, they have a crane to move the fluidizer.

Mr. Salem noted that at both Indian River and Nerang, the discharge point is very close to the downdrift jetty. He asked if there were any problems with re-entry of the material due to reversals in the littoral transport. Mr. Rambo said at Indian River that has not been a problem, although there might be some backflow into the inlet during a northeaster. The State of Delaware would like to have the discharge point about 400 to 600 feet north of the jetty.

Mr. Clausner said at the Nerang River site, the Australians are concerned with channel maintenance. Their discharge point is about 1,000 to 1,700 feet north of the jetty.

Prof. Dalrymple said that during a littoral drift reversal, sand could be expected to come back into the inlet at Indian River. He said it depends on the time of year the State does the bypassing, and they do not plan bypassing at the end of the summer when reversals could be expected.

Mr. Lockhart asked if there were other types of bypassing being considered besides eductor systems. Mr. Rambo said they talked to the Ellicott Dredge Company about dredging equipment that could be used at the site in lieu of the eductor system. It was concluded that the eductors were the best system for Indian River because of the

nature of the project. Use of a conventional dredge would have le.t the equipment much more exposed, for example. The Japanese have a submersible dredge that may have some applications, but it may not be practical for continuous dredging due to maintenance. The eductors are nice because there are no moving parts, and it can be stretched a greater distance from its source of power.

COAST OF FLORIDA STUDY

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ABSTRACT

The Coast of Florida study is the most comprehensive shore protection study ever undertaken by the State of Florida and the Jacksonville District. The study, authorized in 1984, is a cooperative effort between the Corps of Engineers and the Florida Department of Natural Resources, the study sponsor. The study will investigate coastal processes along the State's coastline on a regional basis and make recommendations regarding modifications for existing shore protection and navigation projects.

Study Purpose

The study authorization for the study states that two major topics will be addressed: (1) the previously published reports of the Chief of Engineers pertaining to shoreline erosion on the Florida coast will be reviewed to determine if any modifications to existing projects are necessary; and (2) a comprehensive body of knowledge, information, and data on coastal processes along Florida's coastline will be developed. The study area has been divided into five coastal regions to facilitate study funding and management. The 92 miles of shorefront in Palm Beach, Broward,and Dade Counties (Region III) is the first region being studied due to the large financial commitment in State and Federal funds for shore protection projects in the area. Over $110 million in local, State, and Federal funds has been spent to restore beaches within Region III, and $11 million has already been spent for periodic nourishment after restoration.

National Interest

There are over 90 Federal navigation projects in Florida and 21 authorized Federal shore protection projects. The navigation projects include all of the State's 11 deep-water ports, 30 inlets and passes, and over 2,000 miles of navigation channels, with an annual maintenance cost of $32 million. Of the 151 miles of authorized shore protection projects, 66 miles have been constructed at a cost of about $184 million, $100 million Federal.

State Interest

The State has a threefold program to mitigate or prevent damage to development due to erosion and storms: (1) funding up to 75 percent of the non-Federal share of beach nourishment, (2) preventing unwise development by means of a construction control line, and (3) the purchase of available undeveloped shorefront for preservation of natural resources.

CURRENT STUDY ACTIVITIES

Completion of the feasibility phase of the study for Region III will take 3 years and about $2.8 million for preparation of the feasibility report and Enviromental Impact Statement (EIS). Two directional wave gages have been installed, one at West Palm Beach and the other at Hallandale. The gages, installed by CERC, will supplement the coastal wave data network at the University of Florida. The wave data will be used to verify the CERC 20-year wave hindcast for Region III. The data will also be used to determine the effects of the Gulfstream on wave climate in the region.

Work has begun on developing the data based for the study. The databases are (1) environmental; (2) geotechnical; (3) coastal topography and bathemetry; and (4) economic, including structural improvements and recreation resources. The data will be compiled using a geographic information system (GIS). A contract for two GIS work stations has been recently awarded. A training course to familiarize study participants with the use of the system and the database is planned for later this year, after receipt of the work stations.

A contract has been completed by the US Fish and Wildlife Service to prepare a bibliography of all previous environmental studies. Another contract was awarded in May 1990 to a consultant to collect additional data to characterize a given area and marine habitat.

A final estimate for the geotechnical database is being prepared by CERC. CERC will compile the geotechnical database for the GIS and accomplish additional subbottom profiling and core borings along 92 miles of the study area as needed to complete the acquisition of necessary geotechnical data.

The simultaneous survey (more or less) of the entire region is being conducted in association with DNR and the counties in Region III. The survey will use a combination of DNR, Corps, and Dade and Broward County survey crews. The beach and offshore will be surveyed every 1,000 feet using the State's beach monumentation system. The surveys will extend out to the seaward limit of the third reef line, which

varies from 6,000 feet offshore in Palm Beach County to 14,000 feet offshore in Dade County.

As can be seen, there will be massive amounts of data collected, analyzed, and transferred into databases. The information collected will be accessible to anyone either through technical reports or directly from the computer databases. Once the data collection phase of the study is completed, then regional coastal processes models will be used to examine existing and alternative plans for shore protection and navigation within Region III.

The products expected from the study will be the development of a regional shore protection plan that will maximize benefits versus costs, and comprehensive databases that will be used by Federal and State agencies to manage the use of the natural resources most effectively.

Discussion was deferred until after the following presentation.

A GEOGRAPHIC INFORMATION SYSTEM OF COASTAL GEOLOGIC DATA FOR THE COAST OF FLORIDA EROSION AND STORM EFFECTS STUDY

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As part of the Coast of Florida Erosion and Storm Effects Study, an operational geographic information system (GIS) of nearshore geologic data is being developed. This is one of five integrated databases that are being produced under the Coast of Florida Study. The study has divided the State into five regions, including Region I, panhandle; Region II, the peninsular gulf coast; Region III, southeast Atlantic coast; Region IV, the central Atlantic coast; and Region V, the northeast Atlantic coast. The study participants include the Jacksonville District; State of Florida, Department of Natural Resources, Division of Beaches and Shores; CERC; and the county agencies responsible for erosion control in each coastal county around the state.

Region III has been selected to initiate the study because of the large volumes of existing seismic, bathymetric, geologic, and sediment data of the nearshore areas. Region III encompasses Palm Beach, Broward, and Dade Counties along the southeastern coast of Florida. A GIS with this type of database will provide access to all coastal geologic data in the nearshore area along a coast that contains a large population and expensive upland infrastructure. Persistent shoreline erosion has led to requirements for shore protection by the Corps of Engineers, State of Florida, and local agencies. The preferred erosion control method at the present time along this coast is through beach nourishment. Numerous beach-fill projects have been done along this shoreline, and there is reason to believe that this type of erosion control mitigation will continue in the future. An organized and efficient method of finding suitable and cost-effective sand sources from borrow areas to supply the future fill material requirements is one of the main purposes for development of this GIS.

One of the first tasks in system development is to compile the vast array of coastal engineering geology data that have been collected from past projects. As these data are being collected, they will be entered into the GIS and geo-referenced on a county-by-county basis. Organization of the GIS is accomplished by reducing data into a common state plane coordinate format with a base map developed by the Division of Beaches and Shores. This requires some further analysis or reanalysis of contributed data, which previously existed in incompatible forms. Format of output products will include a common base map developed for all five parts of the Coast of Florida Study. Spatial analysis products include location overlays of bathymetry, hardbottom, seismic

tract lines, core and grab sediment sample locations, and limits of previous borrow area locations. Database products include grain size distribution tables and curves, sediment core logs, and lists of available data (i.e. bathymetry, seismic tracks, sand isopachs) related to the State beach benchmark system. Additional analysis will produce grain size distribution maps, surface sediment type/hardbottom maps, and sediment thickness isopach maps. Computation of volumes of available fill material and identification in three-dimensions of areas of nonsuitable sediments or environmentally sensitive areas will be easily accomplished with development of this GIS system.

Some areas of the nearshore shelf have not been sampled. One of the first tasks is the identification of the missing areas and actual data collection in these areas. With the addition of the missing data, a complete coastal engineering geological GIS, initially for southeast Florida and later the other coastal regions within the State, will aid the coastal engineering community in future cost-effective shore protection project planning and implementation.

DISCUSSION

MG Kelly said that South Pacific Division needed to look at what was being done between Jacksonville District, Mobile District, and the State of Florida, in relationship to the Coast of California Storm/Tidal Waves Study. He said this was an excellent study, and the same thing should be done in California. He asked why so much of the study in Florida seemed to be oriented to borrow material and asked about looking at sediment transport, wave measurements, and erosion rates. Mr. Stevens said there was an immediate need to complete the geotechnical information and determine where they had sufficient borrow source material. That was given some initial emphasis. Mr. Salem added that where there had been early emphasis on geotechnical information on offshore sand sources, they were scheduled to look at the other items mentioned by MG Kelly.

MG Kelly asked what use was being made of the new technology developed by the Dredging Research Program, and whether there was interaction between that program and the work on the Coast of Florida Study. Dr. Stauble said he was not sure the new technology was operational to a point where it could be used for the immediate collection of data. Dr. Houston said as new technology became available, it would be used.

COL Reynolds asked about the accessibility of the archived data. Mr. Stevens said it would be on a mainframe computer stored on their file server. That would be accessible to work stations over ETHERNET.

ENGINEER MANUAL
COASTAL INLET HYDRAULICS AND SEDIMENTATION

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Engineer Manual (EM) entitled "Coastal Inlet Hydraulics and Sedimentation" will provide guidance for the development, improvement, and management of navigation and flood-control projects at tidal inlets. Due to inherent complexities in the morphology, migration patterns, and hydrodynamics of tidal inlets, providing systematic guidance for managing inlets is a most difficult task. An understanding of inlet hydrodynamic processes and their interaction with structural and geomorphic features of the system is necessary to ensure that the design of engineering projects and modification of inlet hydraulics will have minimal impact on the inlet system and adjacent shorelines. The design engineer can gain valuable insight about an inlet by dividing the system into components and accurately assessing or classifying each component. Basic principles for making these determinations and evaluating inlet processes are presented in this EM.

The EM will contain eight chapters: Chapter 1 provides an introduction and overview of the remaining chapters. Chapter 2 describes the geomorphology and morphodynamics of tidal inlets. Inlets are prevalent features along coastlines of the United States. They are most commonly associated with the barrier island shorelines that typify the Atlantic and gulf coasts. Recent surveys suggest that there are more than 140 active tidal inlets from Long Island to Florida; another 160 are inferred from historical maps, charts, and aerial photographs. Because inlets interrupt the continuity of coastal processes, they exert a dramatic influence on shoreline erosional and depositional trends, sediment transport patterns, and sediment budgets. Successful design and implementation of an inlet project require an ability to predict the morphologic behavior of an inlet; this chapter will provide the necessary background information for making such predictive determinations. Various inlet classification schemes are presented, and examples of the types of information that can be gained through geomorphic and geologic analyses are demonstrated. In addition, this chapter will review the general stratigraphy of tidal inlets to provide an appreciation of their three-dimensional variability, ultimate sediment dispersal patterns, and utility as a source of sediment for beach nourishment projects.

Chapter 3 will focus on sedimentation analyses of tidal inlets. Included will be discussions of trapping littoral material in the inlet entrance, updrift and downdrift effects on adjacent shorelines, factors to be considered in an inlet sediment budget analysis, channel migration trends, and various mechanisms of natural sediment bypassing. An example of a sediment budget analysis of an inlet site will be provided.

Hydrodynamic aspects of tidal inlets will be described in Chapter 4. In addition to a presentation of general hydrodynamic parameters, various techniques for evaluating inlet stability will be discussed. Classic work by O'Brien, Bruun, Bruun and Gerritsen, Keulegan, and Jarrett regarding relationships between inlet cross-sectional area, tidal prism, maximum throat velocity, and littoral transport rate will be reviewed and examples provided to demonstrate applications of various stability criteria.

Engineering design of tidal inlets involves either improvement of an existing inlet or development of a new inlet. Structural improvements at inlets may include construction and rehabilitation of jetties, breakwaters, or sand bypassing plants. The ability to anticipate project impacts and implement appropriate measures to alleviate adverse effects is the key to successful design practice. It is also important that the designed features perform their intended functions with minimum maintenance requirements. Chapter 5 discusses design aspects of inlet projects including navigation channel design, jetty design theory and principles, types of construction material, stability considerations, and studies of estimated costs and benefits.

Chapter 6 will describe the physical modeling of tidal inlets. Fluid-flow problems associated with inlet studies generally involve a large number of variables and, therefore, are not always readily solved by simple mathematical approaches. As a result, physical hydraulic models are sometimes used to determine the significant dynamic features of a prototype inlet system. Physical model studies of inlets are typically designed to investigate various methods of maintaining an effective navigation channel through the inlet. Additional inlet-related problems that can be addressed by physical models include optimizing structure dimensions and location, shoaling and scouring trends, tidal prism changes, and salinity effects. Model theory, including assumptions and limitations, will be discussed in this chapter. Fixed-bed and movable-bed models will be described and examples of each provided. Considerations of scale, distortion, historical applications, and the utility of physical models and combined physical and numerical models will be presented.

Numerical models and their application to tidal inlet analysis will be discussed in Chapter 7. Various types of numerical models and modeling systems that have been applied in Corps inlet studies and are available to Corps field offices will be presented. A brief description of each model will be given, followed by sample model runs indicating typical model input and output, calibration and verification procedures,

example model applications, and additional references. Also included will be a section on the engineering use and interpretation of model results.

Chapter 8 will provide guidance related to monitoring existing inlet projects. Criteria necessary to evaluate structure performance, recommended equipment, instrumentation, and surveying techniques will be outlined. Case studies from the Monitoring of Completed Coastal Projects (MCCP) Program will be described as examples of recent CERC inlet studies.

DISCUSSION

Prof. Dalrymple asked if the Manual addresses bypassing and construction technology, that is, things like scour holes and loss of matting material. Ms. Rosati said they are briefly touched on, and the reader is directed to other sources of information, such as the EM on bypassing.

MG Kelly noted that the Corps of Engineers is in the process of updating all of its Engineer Manuals. This particular one is over 20 years old, and the state of the art has changed in 20 years.

Mr. David C. Beach asked if the Manual would apply to riverine entrances, such as they have on the west coast of the United States. Ms. Rosati said she believed it would.

AFTER GITI - THE NEXT PHASE OF TIDAL INLET RESEARCH AT CERC

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Tidal inlet research conducted at CERC after the General Investigation of Tidal Inlets (GITI) effort wound down about 1980 has been conducted under the Harbor Entrances and Coastal Channels program of the General Investigations Research and Development Program. To a degree, the completion of the GITI program served as a damper on tidal inlet research because decision makers felt that they had already contributed to the "inlet cause." However, the principal problem areas with inlets remain much the same: sediment management issues (shoaling, dredging, bypassing, impacts on adjacent shores), structures (improved design, maintenance, scour), and environmental concerns.

Oregon Inlet, North Carolina, provides a case study of a troublesome inlet. The processes active are clearly three-dimensional, nonlinear nonstationary, and highly coupled. Inadequate data on the waves, tides and currents, and bathymetric response make it difficult to forecast how an inlet will respond to natural or man-made changes. This makes engineering of such a system difficult, even though at Oregon Inlet maintenance expenditures probably exceed $5 million per year and bridge and jetty projects exceeding $100 million have been proposed.

Studies of inlet systems generally involved one or a combination from three approaches: field, physical model, and numerical model studies. Recent advances in instrumentation make it more feasible to take scientific level measurements in inlet systems than in the past, but difficulties still remain in the interpretation of the data and in making observations in high-energy or high-traffic areas. Field studies are excellent for defining existing conditions but are not very useful for prediction purposes. Physical models based on a Froude scaling have been extensively used both in a fixed bed and more rarely in a movable bed mode. Physical models are particularly useful in trying to improve channel and structure designs. Principal limitations are in cost and in the technical limitations that not all processes are simulated. The reliability of movable bed models is unknown. It is almost impossible to perform a long-term simulation in a physical model. Numerical models offer considerable flexibility, and the advent of the supercomputer provides ample computation power. Most numerical models of inlets are currently limited in terms of the level of physics and processes included and have not been sufficiently proven to be widely accepted.

Research at CERC has been directed at improving the Corps' capability to predict inlet hydrodynamics numerically, to develop instruments capable of measuring sediment transport in inlets, and collecting laboratory data that can be used to improve inlet models. Coordination with the Field Data Collection Program and Monitoring Completed Coastal Projects Program has been necessary to develop field data sets. Given the limited funding available, progress has been accordingly slow.

DISCUSSION

Prof. Raichlen said he thinks it is very important to look at some aspects in the laboratory where control of the parameters was better than in the field. It was very important in assisting to validate the models. He agreed with Dr. Bernard Le Méhauté's assessment at a previous Board meeting that CERC needs large-scale laboratory facilities. Some things need to be looked at in a large-scale laboratory. Dr. Vincent agreed with that.

Prof. Reid asked about the possibility of using acoustical tomographic methods in assessing currents in the inlet. Dr. Vincent said that is an area that probably should be investigated; it is in the remote sensing area in emerging technologies.

CERC'S NEW NEARSHORE DIRECTIONAL WAVE GAGE

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Introduction

Waves are the forcing function for most sediment transport processes. Coastal structure stability and armor unit strength analyses require wave input. Modeling and measurement of waves are fundamental to both the practice of coastal engineering, as well as research efforts to improve the analysis tools available to the coastal engineer. Although the hydrodynamics of gravity waves has been sufficiently described for many years, progress towards the solution of the governing equations has been slow, even for the most trivial of cases. In recent years, computer simulation of hydrodynamic equations through the use of grids of finite elements or differences has improved the ability to analyze wave characteristics in intermediate and shallow water. However, these models require adjustment or calibration to site-specific, measured data to yield approximately reliable results. More exact solutions would require increases in spatial or time-step resolution beyond the capability of present day supercomputers. Since computational hydrodynamics is of the n^2 or n^3 class of algorithm time dependence and increases of computing performance are of order n, it is likely that coastal hydrodynamics will share dependence upon prototype scale measurement with meteorology for the foreseeable future.

The importance of wave direction as a component of coastal wave measurement is well recognized by coastal engineers. In sediment transport, estimates of longshore currents are highly sensitive to the angle at which breaking waves intersect the beach. For coastal structures, adequate physical modeling of stability requires careful attention to the angle of wave approach. Jetty, channel, and inlet designs are tuned to the local directional wave climate.

The majority of directional wave data collected by the Corps of Engineers has been acquired by two types of systems. The S_{xy} arrays of pressure transducers were deployed primarily on the west coast for synoptic monitoring of nearshore wave direction. Self-contained recording gages with a single pressure transducer and a two-axis electromagnetic current meter known as a *PUV* gage have been routinely used for many years by CERC and coastal Districts for site-specific studies of limited duration. Both of these systems have remained essentially unchanged for the last 10 years (Dean 1982).

Given the availability of these systems, why are most coastal designs, physical models, numerical models, and planning exercises conducted without the benefit of measured directional wave data? The answer lies in a combination of high initial and lifetime cost, low confidence in success, and the technical and logistical difficulty of preparation, deployment, recovery, and data analysis for relatively complex instruments.

Today, many thousands of miles of US coastline, including entire Corps Districts, are without an effective, reliable, and economic means of obtaining either short-term or synoptic directional wave measurements.

Design Requirements for a New Wave Gage

The objective is to develop nearshore directional wave gage technology as an engineering tool. There is an urgent need to have an improved directional wave gage for Corps site-specific studies as soon as possible. Therefore, the most promising of the *already developed* directional measurement concepts will be rapidly engineered into a practical, reliable, and economic instrument available for District use. The design evaluation was based on the following requirements. The gage should measure the wave height directional spectrum in intermediate water depths. The gage should be capable of cable operation, telemetry, or internally recording data without external power or service for up to 13 months. If the gage is *in situ*, it should have a physical configuration which makes it resistant to trawler damage, and it should be both deployable and recoverable without divers. It should have a rugged mount with an anchoring system suited for operation in a wide range of sea conditions from the Pacific northwest to hurricane conditions in Florida.

After a careful review of all the existing methods of directional wave measurement, a system based on principles similar to those of Bodge (1982) was selected. The system will employ a short baseline array using absolute reading pressure transducers rather than differential. The development of the high-resolution, Paros Digiquartz pressure transducer has made such a concept feasible. Eliminating the differential pressure transducers removes the complex tubing system which was the main construction and reliability problem of the differential pressure gage.

DWG-1

The DWG-1 is a low-profile, hemispherical structure, 8 feet in diameter, which is anchored on the bottom using a surface-operated, diverless deployment system. The gage in its basic configuration will contain three Paros pressure sensors in a 2-meter, equilateral triangle array. An optional redundant configuration will have six

transducers in a *Star of David* configuration. The gage will contain an internal microcomputer system to perform data analysis, recording, and transmission. The standard version will record unique co- and quad-spectra from all combinations of transducers. Spectra will be recorded every hour for 13 months. This partly analyzed data will be postprocessed to yield directional spectra. Directional spectra will be estimated using either a Longuette-Higgins, Cartwright, and Smith (1963) analysis or any of the more recent high-resolution methods. Mean water levels (tides) will also be available.

The DWG-1 will implement reliability and cost-saving features to enhance construction, check out, calibration, transport, deployment, recovery, and data analysis. By attention to cost reduction in each of these areas, the total cost of ownership can be brought within the range of every Corps project. A major contribution in this area is the simultaneous development of a diverless deployment and recovery system. The deployment system provides the additional benefit of providing an accurate measurement of gage orientation during installation. Uncertainty of gage orientation has traditionally been one of the major limitations of bottom-mounted directional wave gages.

Conclusion

The direct benefit of this development will be a minimum 50-percent reduction in the cost of directional wave measurement to the Corps of Engineers. It is anticipated that rather than a reduction of outlay, there will be a significant increase in the quantity and quality of directional wave data acquired in support of the Corps' mission.

The indirect benefit will be the improvement to Corps design and planning by allowing the use of the new methodologies which require nearshore, site-specific directional wave data as input. These benefits will be realized by reduction in design margins, reduced maintenance requirements, and improved project performance.

References

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DISCUSSION

Prof. Raichlen asked about the water depth where the gages were deployed. Mr. Howell said they deployed the gages in water depths less than 15 meters because of the pressure transducers. In water depths greater than 15 meters, the data from the transducers start to degrade, i.e., the signal-to-noise ratio becomes too low. With older pressure transducers, it was necessary to stay within 10 meters.

Prof. Reid asked if the tilt of the instrument affected the measurements. Mr. Howell said that is not a problem because they are absolute pressure transducers.

Mr. John W. Adams asked how they guided the retrieval module back to the system and how they transmitted information back to the shore. Mr. Howell said the recovery module is permanently installed. A line can be sent back to the surface, and an air supply attached to jet the pipes in the assembly. It is then pulled up on the load line. He said data recovery could be in real time by connecting a cable either to the shore or to a buoy that would transmit to a satellite.

COL Reynolds asked about the statistics of the wave record. Mr. Howell said they were doing a statistical sampling, and there were confidence limits that went with that. They recommended a minimum of 3 years data for Corps site-specific projects. They would like to have much longer records, but they were not going to get those.

Dr. Dean asked about the separation distance between the gages. Mr. Howell said they had a computer model developed by Dr. Michael Andrew where they could vary both the geometry and spacing. They found that directional accuracy is much less sensitive to gage spacing than what would be assumed. It is a factor, but not a linear factor. That was confirmed with a field test at SUPERDUCK. The degradation between spacings of 8 and 6 feet is very minimal. They have not looked at directional spreading a lot because it is a shallow-water gage. They have to be very careful that they do not introduce any error that is correlated with the wave direction. As long as errors are uncorrelated, they are filtered out.

COL Wilson asked about the development cost and the number of units that were going to be developed and produced. Mr. Howell said the project has been funded on the order of $200,000 per year for 4 years, with a total cost on the order of a million dollars by the time the work would be completed. The target construction cost is $15,000 per gage. He thought the actual cost would be between $15,000 and $20,000. The target operational cost, for 50 to 100 gages installed, is on the order of $15,000 to $20,000 per gage per year, depending on where the gage is installed. He expected a higher demand for wave gaging as the costs come down. Japan has 200 gaging sites around their coastline. He could foresee having 200 to 300 gages operational around the United States at a future date.

SCANNING HYDROGRAPHIC OPERATIONAL AIRBORNE LIDAR SURVEY SYSTEM (SHOALS)

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Introduction

The US Army Corps of Engineers (USACE) conducts an extensive annual hydrographic surveying program in support of the planning, design, construction, and maintenance of Federal projects. The USACE surveying program covers a broad range of project types including flood control, navigation, and erosion control. The most resource-demanding survey requirement is the need for quick and accurate bathymetric surveys of riverine, coastal, harbor, lake, and channel areas.

Present USACE hydrographic surveys are performed by small launch-type vessels (20 to 70 feet) with acoustic Fathometers. The USACE owns and operates many of these vessels for bathymetric surveying, and a significant additional amount of work is performed by contractors. Horizontal control for both is usually provided by a microwave range/range or range/azimuth system, and vertical control depends on standard Fathometer calibrations such as bar checks coupled with tide or river gages and associated water surface elevation interpolation/extrapolation techniques.

Although USACE has tested other bathymetric surveying technologies, several of them, such as the SWATH motion-compensated catamaran and the high-speed RODOLF system, are being used on a limited scale. However, the USACE needs technology that can augment existing survey methods at comparable costs without requiring significant additional manpower to operate or administer. An airborne system that can achieve orders of magnitude increases in survey speed has the potential to meet this requirement. Thus, the USACE began a cost-shared project with the Canadian government to design, construct, and field verify an airborne lidar bathymeter surveying system. The program is intended to build on experience gained by the Canadian Hydrographic Service in operating a similar system from a fixed-wing aircraft. The program is implemented through a joint Memorandum of Understanding under the United States/Canadian Defense Development Sharing Program.

The SHOALS Program

Program organization includes WES as the study manager with funds and program monitoring provided by both the USACE Headquarters and the Canadian Department of Industry, Science, and Technology. The program includes a Field Working Group composed of representatives from USACE Field Offices, which will be the ultimate users of the SHOALS system. A group of Technical Specialists from academia and the National Ocean Service reviews reports, tests, and products throughout the program.

The program is two-phased. Phase I was initiated in March 1988 and completed in March 1989. Products included the system's performance specifications and expected operational restrictions, the system conceptual design, and an economic feasibility analysis.

Phase II was initiated in March 1990 and will require approximately 36 months to complete. It will consist of the design, construction, and field testing of an operational prototype system.

To provide additional incentive for the contractor to exceed the system performance requirements, the contract type is a Cost Plus Award Fee. Estimated total costs of the program are $3,623,000 for the Canadian share and $6,788,000 for the US share, including the field tests which are funded solely by the United States.

System Design and Use

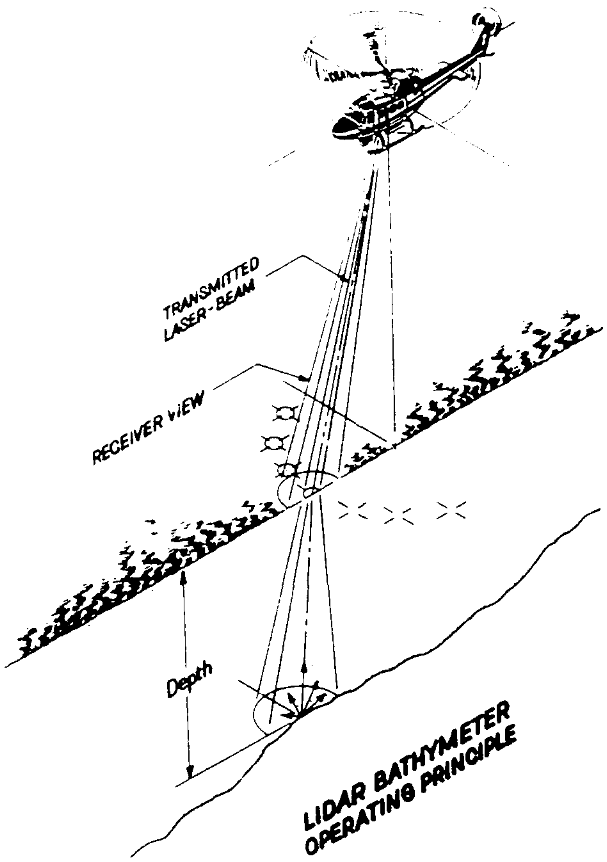
The SHOALS system will operate out of a Bell 212 helicopter at approximately 200 meters altitude. At that altitude, the laser will scan a survey swath of just over 100 meters. System requirements dictate a laser operating at 200 Hz in the blue-green wavelength for maximum water-depth penetration. Each laser shot strikes the water surface at a known location where its energy is partially reflected back to the receiver, and partially transmitted through the water column. Transmitted energy is reflected back from the bottom to the receiver, and the difference in time between the surface return and the bottom return determines depth. The system is intended for use in water depths from approximately 1.5 to 35 meters. Horizontal control will be provided either by microwave or the NAVSTAR Global Positioning System (GPS).

System components include an Nd:YAG laser transmitter/receiver with scanning device; an onboard system to acquire, initially process, and store all sensed data such as time, depth, and position; a system to provide the pilot with real-time navigation guidance; an aircraft attitude recorder for removing aircraft pitch and roll; a horizontal positioning system; and a status panel so the onboard operator can monitor system parameters and confirm that valid data are being collected. A ground-based system

which postprocesses the collected data will produce as the final system product a fully corrected and quality-checked file of position and water depth referenced to standard survey control.

Summary

The performance capabilities of the SHOALS system will greatly extend the abilities of the USACE to undertake a broad range of survey applications more effectively. The SHOALS system represents a significant step forward in hydrographic survey technology compared with existing methods and a generational step in airborne lidar bathymetry operational capability. This new technology, however, will not replace the present acoustic systems but will be complementary. By using each technology in situations best suited to its capabilities, the overall ability of the USACE to fulfill their mandate will be greatly enhanced.



DISCUSSION

Prof. Dalrymple asked what effect the water quality, salinity, or temperature would have on the accuracy of the readings, including effects from three-dimensional variations in the sea's refraction. Mr. Lillycrop said that water quality could have a significant effect and would affect what projects it could be used on. Temperature and salinity do not affect it nearly as much. A clear thermocline would not affect it that much, but material on the thermocline would. They were looking primarily at shallower depths of water, so thermoclines and stratifications should not be that important.

Prof. Raichlen asked about laser power. Mr. Lillycrop said it uses 5 milli-Joules for each pulse, and the actual pulse width is about 5 nanoseconds.

Mr. Gilbert K. Nersesian asked about conditions where there were silts and very loose muds in the bottom of the water column. Mr. Lillycrop said there were limitations on the system, and it would not completely replace the Fathometer. It would tend to reflect from near the top of material such as loose muds.

Mr. Nersesian asked about the surf zone. Mr. Lillycrop said that selection of the time for the survey was important. If the waves were not breaking, one would be able to survey to a depth of about 1-1/2 meters minimum. Breaking waves would give problems because of the foam.

COL Wilson asked what kind of assumptions were made on the inventory of equipment and the staffing for that equipment. Mr. Lillycrop said that they assumed a requirement for a field crew of four people, two for the system in the aircraft and two to set up horizontal positioning equipment and install the tide gages. They assumed 2 days mobilization and 2 days demobilization. It would be most efficient if projects could be grouped, to survey many projects at the same time. The mission hours and the acquisition costs are really the most important factors.

Prof. Raichlen asked if this would be turned over to the various Corps Divisions, or if there would be a group dedicated to operating the system. Mr. Lillycrop said that was one of the things the Field Working Group was looking at. In Canada, they have a government-owned/contractor-operated system.

PUBLIC COMMENT

Mr. Neil H. Cargile, Cargile Company, spoke about a new semi-submersible dredge his company had constructed, which might be used for sand bypassing. It has been under development for about 15 years, at a previous company he owned that built dredges. It is like a standard canal dredge, with wheels instead of pontoons. It is 60 feet high and weighs 175 tons, with a capacity of 1,000 cubic yards an hour, and can pump about 4,000 to 5,000 feet. He feels it is more cost effective than the Japanese semi-submersible dredge that was mentioned earlier in the meeting. It can work in much shallower depths than a standard dredge. They also have a remotely operated version. He claimed it was more effective than a jet pump system, with an operating cost of 1 to 2 dollars per cubic yard plus mobilization costs. It can be carried on a catamaran-type barge and be dropped in place.

Mr. James McCartney Wearn, attorney for South Lake Worth Inlet District, said the District would provide facts on the inlet to anyone who requested them. He asked that people be careful in having correct information and noted that in recent litigation some facts had been misrepresented. He also said that people should allow sufficient time for fact finding before proceeding with a final report. He noted that the inlet is quite shallow, a 5-foot design depth, and has a fixed bridge. It is intended for water circulation, not navigation, and navigation use is incidental. He claimed the shoreline south of the inlet has not suffered as a result of the inlet, and that surveys over the past 110 years support that.

Mr. Aram Terchunian, Coastal Stabilization, Inc., spoke about beach-face dewatering, and the project at Sailfish Point, updrift of St. Lucie Inlet. He noted that beach-face dewatering had been observed as early as 1940. The principle is very straightforward; the higher the water table, the more tendency there is for erosion due to wave action because of the effluent discharge through the beach face, which has a tendency to mobilize the sand. He presented results of 2 years of surveys at Sailfish Point, which showed that beach dewatering had stabilized a section of shoreline about 600 feet long, while adjoining sections had eroded and retreated. He invited participants at the Board meeting to visit Sailfish Point.

Mr. John W. Adams, StaDeep Systems, Inc., said he appreciated the invitation to attend the Board meeting. He said he had learned a great deal at the meeting and thought that it would be very helpful to the Corps' reputation if other people knew how much was going on and what was going on. He said the Corps suffered from a reputation it did not deserve.

Mr. Adams noted the great increases in productivity in various industries and the great advances in some areas of technology. He said that during the same period of

time, the coastal industry had proceeded at a glacial pace. It was pointed out at the meeting that some of the reasons for that were social and political. He thought that the brightest and the best in the coastal industry were greatly held back and that there were things the Board could do to improve the situation.

Mr. Adams noted the long period of time required to test something in the field. He wondered if it was possible to have a "skunkworks" in the Corps of Engineers and saw that possibility at WES. He thought a lot of the ideas people have could be tested very rapidly in the wave tanks. A suggestion to the Board was to get increased funding for the wave tanks and modeling and make this the "skunkworks" for the Corps to get some things solved.

Mr. Adams said he was appalled to hear that our scientists in the Corps do not have the freedom to travel and see how other people do things, and he thought that dated from the Jones Act. He said the cold war is over and the Jones Act is redundant. It prevents us from having the latest technology. There are finer and better technologies around the world than we are permitted to use in the United States.

BOARD RECOMMENDATIONS

Prof. Dalrymple said that, during the meeting, they had seen plenty of examples where tidal inlets have caused downdrift erosion of beaches. It was pointed out that a significant portion of the beach erosion in Florida is associated with tidal inlets. There are examples around the country where downdrift erosion is very significant. There are some obvious conclusions that can be drawn. The first conclusion is that the Corps of Engineers should stop the offshore disposal of beach quality sand taken from navigational channels in inlets and place that material on downdrift eroding beaches. The second conclusion is that the Corps of Engineers ought to assess all inlets, either constructed or maintained by the Federal government, for downdrift erosion due to inlets; and they ought to remedy these problems, as soon as possible, with either permanent bypass systems or a rigorous maintenance dredging program.

Prof. Dalrymple said that any new construction carried out by the Corps of Engineers at a tidal inlet should include a workable sand bypass system. Funding for the maintenance of that system should also be provided.

Prof. Dalrymple also commented on the construction of jetties at inlets. When a jetty is constructed by a District, it is a unique design experience. All inlets are different to a certain extent. Construction techniques are different, and the response of the inlet during construction is different. The experience gained by the District is largely kept within the District. He thought there needed to be a mechanism whereby the construction experience gained by one District was shared with the entire Corps. The problem was exacerbated by the turnover of design engineers within the Districts, so that the experience gained on a project was lost by the departure of one or more individuals and, therefore, every new jetty construction project was a new project for the engineer in charge. Maybe there should be a new publication in the future which deals with construction practices of building jetties and inlets.

Prof. Raichlen said he concurred with the comments made by Mr. Adams during the public comments on the problem the Corps is having in terms of being able to send people to foreign meetings and to visit foreign laboratories. He noted that the International Conference on Coastal Engineering would be held in Delft, The Netherlands, the following month. CERC was authorized to send only three people to the meeting on official travel, and that put CERC in a bad light compared with other major laboratories. The National Laboratory of The Netherlands is at Delft, where the meeting is being held, but the Chief of CERC is not able to go there. Prof. Raichlen was hopeful that would be corrected in time, and he thought it was quite important.

Prof. Raichlen said it would be appropriate at the next Board meeting, in New Orleans, to get a report of what was happening with regard to wetlands studies within

the Corps of Engineers, more specifically, what was happening to coastal wetlands and how the Corps was viewing coastal wetlands preservation and the environmental problems associated with coastal wetlands.

Prof. Raichlen said the upcoming Board meeting on coastal structures was very important. There were a bunch of aging structures around the coastline of the United States that would need maintenance and rehabilitation. He thought this was the type of topic that really should be given some attention. He noted that he has had the opportunity to visit CERC at three different locations over the years, and he still believed that there was a very important need for experimental facilities. He thought there was a significance in maintaining, upgrading, and modernizing our experimental facilities, such as CERC was doing now with their directional wave generators and the laser doppler techniques being put in place. He thought what was really needed was a very large three-dimensional facility that could be used to look at physical models, as such in terms of rehabilitation, where some of the important problems and questions are ones of scale. We needed to be able to do things at a large enough scale to have assurance of the results that we obtain.

Prof. Raichlen said there was a large trend towards developing numerical models that need some sort of validation. Validation in nature was very important, but perhaps we could learn a lot in large-scale laboratory facilities. He did not think PRIP funding was the appropriate way to finance such facilities, and other means of funding should be considered.

Prof. Reid said he would like to endorse Prof. Dalrymple's comments with regard to his recommendations on inlets and sand bypassing. He would also like to endorse the comments made with regard to foreign travel. He said it was encouraging that the Corps was able to have a US-Canadian joint development for the SHOALS project.

Prof. Reid said that Dr. Raichlen had already made a request for a report on wetlands at a future Board meeting. He would like to encourage having a report from the Coastal Field Wave Gaging Program at the meeting on coastal data collection. He also recommended having a report on the Monitoring Completed Coastal Projects Program at a future meeting, on comparisons of what was found from the monitoring program compared with design of particular projects.

COL Wilson said it would be worthwhile to invite the US Geological Survey and the Minerals Management Service to a future meeting, and also have a report from the Corps on their efforts in mapping sand resources. We should take advantage of the ongoing efforts of other agencies and maybe cooperate to pool our resources, to get the most we could out of the taxpayer's dollar, to advance the efforts of coastal engineering. CERC should take the lead in preliminary coordination of that effort.

COL Wilson said he would like to pursue, as a Board recommendation, the recommendation to identify coastal engineers as a category of the Civil Engineers.

COL Wilson noted that it was his last meeting as a member of the Board, and his time as a member had been a personally and professionally rewarding experience.

THEMES FOR FUTURE MEETINGS

The next meeting will be in New Orleans, Louisiana, in June 1991. The theme will be Coastal Flood Protection. The meeting following that will be in the New England Division area in the fall of 1991, and the theme at that meeting will be Dredging.

In the spring of 1992, the tentative theme is Coastal Structures; in the fall of 1992, the Board is considering a theme of Coastal Data Collection; and in the spring of 1993, Coastal Engineering with a particular emphasis on Pacific Islands. The location of the last mentioned meeting will probably not be in the Pacific Islands.

CLOSING REMARKS

Appreciation was expressed to the presenters at the meeting and to the panel members. Recognition was given to South Atlantic Division and specifically Jacksonville District for outstanding support of the CERB meeting. COL Malson was thanked for the exceptional logistics support provided for the meeting, along with all of the District personnel who had worked on the meeting and provided help to the Board. Thanks were extended to the CERC staff for their contributions to the meeting. Earlier in the meeting, MG Kelly had noted that a recent inspection of Board operations had commended CERC, and specifically Ms. Hanks, for their professional support of Board activities. Thanks were also extended to Ms. Milford, who recorded the meeting.

COL Wilson said at the last two meetings he had the opportunity to act as President of the Board on three occasions, and now he had the opportunity to adjourn a Board meeting for the second time. The 53rd Meeting of the Coastal Engineering Research Board was adjourned.

APPENDIX A
BIOGRAPHIES OF SPEAKERS/AUTHORS

JAMES E. CLAUSNER

Mr. Clausner is a hydraulic engineer with the Coastal Structures and Evaluation Branch of the Coastal Engineering Research Center (CERC), US Army Engineer Waterways Experiment Station (WES). He joined CERC in 1981 after several years at the Naval Civil Engineering Laboratory, where he was involved in design and testing of propellant embedment anchors and measuring submerged sediment properties. In his present position at WES, Mr. Clausner is responsible for research on sand bypassing projects and equipment. He received his B.S. and M.S. degrees in ocean engineering from Florida Institute of Technology. Mr. Clausner is a registered professional engineer in the State of Mississippi.

ROBERT W. CLINGER

Mr. Clinger has been employed by the Palm Beach County since 1973. Prior to serving as the coordinator of the Beach Erosion Control Program, he worked in the Permitting Section of the County Engineer's Office. His work included coordinating with coastal municipalities and inlet districts and serving as staff to the Palm Beach Countywide Beaches and Shores Council. He also coordinated with State and Federal agencies securing funding and permits for coastal erosion control projects. In October 1987, the Beach Erosion Control Program was transferred to the newly created Department of Environmental Resources Management. Mr. Clinger has been a director on the Florida Shores and Beach Preservation Association since 1988.

DR. ROBERT G. DEAN

Dr. Dean is presently a Graduate Research Professor in the Coastal and Oceanographic Engineering Department at the University of Florida. He obtained a B.S. degree in civil engineering from the University of California, Berkeley; an M.S. degree in civil engineering from Texas A&M University; and a Ph.D. degree in civil engineering from the Massachusetts Institute of Technology. Dr. Dean is a registered professional engineer in the State of Florida, a member of the National Academy of Engineering, and a member of the American Society of Civil Engineers. He is a past member of the Coastal Engineering Research Board, serving from June 1969 to June 1981. His past experience is in consulting as well as research and development, primarily in the field of coastal and ocean engineering. Dr. Dean has over 80 publications in the areas of coastal erosion, wave force analysis, wave theories, and coastal structure design.

COL LARRY B. FULTON

COL Fulton became the 25th Commander and Director of WES in August 1989. Prior to his assignment at WES, he served as the Assistant Chief of Staff Engineer for the Southern European Task Force in Vicenza, Italy. COL Fulton has a B.S. degree in civil engineering from the University of Colorado and an M.S. degree in civil engineering from Oklahoma State University. He is also a graduate of the Industrial College of the Armed Forces. Other command assignments include Company Commander, 70th and 84th Engineer Battalions, Vietnam; Commander 4th Engineer Battalion, 4th Infantry Division (Mechanized), Fort Carson, Colorado; and Commander and District Engineer of the Far East District, Korea. His major staff assignments include Egypt Area Engineer, Middle East Division; Assistant Director of the Directorate of Engineering and Construction, Headquarters, Washington, DC; Deputy District Engineer, Omaha District; Instructor, Department of Tactics, Fort Leavenworth, Kansas; Resident Engineer, US Army Engineer Command Europe, Augsburg, Germany; Executive Officer, 20th Engineer Battalion, Vietnam; and Platoon Leader and Operations Officer, 23rd Engineer Battalion, Germany.

KATHYRN J. GINGERICH

Ms. Gingerich is a Research Physical Scientist with the Coastal Processes Branch, Research Division, CERC, WES. She received a B.S. degree in geology/secondary education from the College of William and Mary and is presently completing her Ph.D. degree in geology through Old Dominion University. Ms. Gingerich is a member of the American Geophysical Union and Society of Sedimentary Geology.

KIRBY G. GREEN III

Mr. Green is Director of the Division of Beaches and Shores, Florida Department of Natural Resources. Prior to his appointment to this position, he held positions as Assistant Director of the Division of State Lands and as State Cadastral Surveyor for the State of Florida. In those positions he was responsible for implementation of the State's tidal boundary mean high-water determinations and management of State-owned submerged lands. Mr. Green has 10 years of private consultant experience in civil engineering, land planning, and surveying prior to joining the Department of Natural Resources. He was educated at the University of Florida in civil engineering and has graduate level work in applied geodesy at George Washington University.

J. MICHAEL HEMSLEY

Mr. Hemsley is a Program Manager for the CERC, WES. He has been with CERC as either an Army officer or a civilian since 1973. During his tenure at CERC, he has been principally involved with the development and conduct of monitoring/data collection efforts. Currently, he manages two national data collection programs, the Monitoring Completed Coastal Projects Program and the Coastal Field Data Collection Program, with a total value of $4.3 million. Mr. Hemsley graduated from John Hopkins University with a B.E.S. degree in geophysical fluid mechanics and from George Washington University with an M.S. degree in harbor, coastal, and ocean engineering. He is a member of the American Society of Civil Engineers, American Shore and Beach Preservation Association, and Permanent International Association of Navigation Congresses. Mr. Hemsley is a registered professional engineer in the Commonwealths of Virginia and Pennsylvania.

DR. ALBERT G. HOLLER, JR.

Dr. Holler is Chief of the Hydraulics and Coastal Engineering Branch, Engineering Directorate, US Army Engineer Division, South Atlantic (SAD), in Atlanta, Georgia. He has worked in SAD since 1972. Prior to working in SAD, he worked in the US Army Engineer Division, Ohio River, in Cincinnati, Ohio. Dr. Holler received a B.S. degree in civil engineering from the University of Michigan and M.S. and Ph.D. degrees from the University of Cincinnati. He is a registered professional engineer and member of the American Society of Civil Engineers.

JOHN G. HOUSLEY

Mr. Housley is the senior coastal engineer in the Planning Division, Directorate of Civil Works, Headquarters, US Army Corps of Engineers (HQUSACE). He received a B.S. degree in civil engineering from Lehigh University and an S.M. degree in civil engineering from Massachusetts Institute of Technology. His entire professional career has been with the Corps of Engineers, first with WES, then the US Lake Survey, where he conducted hydraulic and coastal research. His present assignment is in the Flood Plain Management Services and Coastal Resources Branch, HQUSACE.
Mr. Housley was the Program Manager for the Shoreline Erosion Control Demonstration Program.

DR. JAMES R. HOUSTON

Dr. Houston is Chief of the CERC, WES. He has worked at WES since 1970 on numerous coastal engineering studies dealing w' . explosion waves, harbor resonance, tsunamis, sediment transport, wave propagation, and numerical hydrodynamics. He is a recipient of the Department of the Army Research and Development Achievement Award. Dr. Houston received a B.S. degree in physics from the University of California at Berkeley, an M.S. degree in physics from the University of Chicago, an M S. degree in coastal and oceanographic engineering, and a Ph.D. in engineering mechanics from the University of Florida.

GARY L. HOWELL

Mr. Howell is a research engineer in the Prototype Measurement and Analysis Branch, CERC, WES, a position held since November 1983. He received B.S. and M.S. degrees in electrical engineering from the University of Florida. He has held engineering positions in industry with IBM Corporation and Honeywell-Bull, France. He served as assistant director of the Coastal Engineering Laboratory at the University of Florida until 1983. While there, Mr. Howell developed the Florida Coastal Data Network field wave and storm surge measurement system. He has served as a consultant in the areas of coastal and ocean instrumentation and maintains current research interests in the development of advanced instrumentation and data analysis techniques for coastal and ocean engineering. Mr. Howell is a member of the Institute of Electrical and Electronic Engineers and Eta Kappa Nu, and he is a registered professional engineer in the State of Florida.

WILLIAM T. HUNT

Mr. Hunt is currently assigned as Economist to the Economics and Social Analysis Branch, Policy and Planning Division, HQUSACE, Washington, DC. He has been with the Corps of Engineers for 20 years, most of that time as an economist in water resource planning and economic evaluation. Assignments have included Norfolk District (1970-73 and 1974-76); the Corps of Engineers Planning Fellowship Program, Cornell University (1973-74); North Pacific Division (1976-77); Pacific Ocean Division (1977-88); Army Housing Office, US Engineering and Housing Support Center (1988-1990); and his present position since February 1990. He attended the United States Naval Academy and graduated from Old Dominion University with a B.A. degree in economics. He has

done graduate study in economics at Old Dominion University and in resource economics and planning at Cornell University.

JEFF LILLYCROP

Mr. Lillycrop is a coastal engineer in the Coastal Structures and Evaluation Branch, Engineering Development Division, CERC, WES. He received a B.S. in engineering sciences (1981) and an M.S. in coastal and oceanographic engineering (1983) from the University of Florida. Mr. Lillycrop worked 2 years in the Jacksonville District's Coastal Planning Branch on a variety of erosion control and hurricane protection projects. Since joining CERC in 1986, he has worked on several District-sponsored studies on inlet stability and on a research effort on design criteria for shallow-draft coastal ports; he is the principal investigator of the SHOALS program.

T. NEIL McLELLAN

Mr. McLellan is a hydraulic engineer with the Coastal Structures and Evaluation Branch of the CERC, WES. He is primarily responsible for planning, managing, and performing studies to characterize dredging and dredged material placement in the coastal zone. He serves as a principal investigator for the Dredging Research Program (DRP). Previous experience at WES includes evaluation and management of dredging and disposal of contaminated dredged material.

Mr. McLellan received his B.S. degree in civil engineering from the University of Texas at Austin and his M.S. degree in ocean engineering from Texas A&M University. He is a registered professional engineer in the State of Texas and an associate member of the American Society of Civil Engineers and member of the Marine Technology Society.

E. CLARK MCNAIR, JR.

Mr McNair is the Program Manager for the DRP, CERC, WES. The DRP is an integrated, multi-disciplinary research program that addresses the operational and managerial aspects of dredging. Previously, Mr. McNair worked in research areas of sediment transport, estuarine processes, tidal hydraulics, and several areas of dredging. He received the Commander and Director's Research and Development Award and the Department of the Army Research and Development Award for his work.

Mr. McNair received his B.S. and M.S. degrees in civil engineering from Mississippi State University. He is a member of the American Society of Civil Engineers, the Permanent International Association of Navigation Congresses, and the Western Dredging Association. He is a registered professional engineer in the State of Mississippi.

DAVID R. PATTERSON

Mr. Patterson is a coastal engineer in the Coastal Engineering and Design Section of the US Army Engineer District, Los Angeles, and is the design engineer for the Experimental Sand Bypass in Oceanside, California. He received a bachelor's degree in oceanography from Florida Institute of Technology and has worked as an oceanographer and coastal engineer for over 14 years. Prior to joining the Corps, Mr. Patterson was a senior oceanographer with Tetra Tech, Inc., performing site-selection investigations and coastal engineering design throughout the Middle East, Alaska, and the United States.

JOAN POPE

Ms. Pope is Chief of the Coastal Structures and Evaluation Branch, Engineering Development Division, CERC, WES, and is responsible for overseeing the work of the Engineering Applications and Coastal Geology Units. This Branch includes civil, ocean, and coastal engineers, geologists, and oceanographers who are involved in evaluating and analyzing the application of research and development technology to coastal engineering problems. Ms. Pope holds a B.S. degree from the State University of New York at Oneonta and an M.S. degree in geology from the University of Rhode Island. She started work at CERC in 1983 after working for approximately 10 years on coastal projects for the Buffalo District. Her research interests include development of design criteria for segmented breakwater systems, coordination of the development of a helicopter-mounted laser bathymetry system, application of geologic and coastal processes to projects design, and WES's Study Manager for the Kings Bay Monitoring Program. Ms. Pope is a registered professional geologist in the State of Indiana.

AUGUSTUS T. RAMBO

Mr. Rambo is presently the Acting Chief, Civil and Structural Section, Design Branch, Engineering Division, US Army Engineer District, Philadelphia. He graduated

from Drexel University, Philadelphia, Pennsylvania, in 1975 with a B.S. degree in civil engineering. Mr. Rambo is a licensed professional engineer.

JULIE D. ROSATI

Ms. Rosati is a Research Hydraulic Engineer with the Coastal Processes Branch, Research Division, CERC, WES. She received her B.S. degree in civil engineering from Northwestern University in 1984, and obtained her M.S. degree in civil engineering from Mississippi State University in 1988 through the WES Graduate Institute. She is a professional engineer in the State of Mississippi and is a member of the American Society of Civil Engineers.

DAVID V. SCHMIDT

Mr. Schmidt is a civil engineer with the Coastal Section, Planning Division, US Army Engineer District, Jacksonville (SAJ). He graduated with a bachelor of science degree in ocean engineering from Florida Atlantic University in 1975. He is a senior staff member with 11 years of experience in the planning and design of shore protection projects. He is responsible for all continuing authority shore protection studies in Puerto Rico and the US Virgin Islands. He provides coastal engineering expertise to the Department of Planning and Natural Resources, US Virgin Islands, as part of the District's Section 22 Technical Assistance Program. Mr. Schmidt is currently serving on the Corps panel that is overseeing the development of the National Economic Development Procedures Manual for Coastal Storm Damage and Erosion. He played a major role in the development of the computer program used in SAD to compute storm damage benefits. He received the Planner of the Year, Planning Excellence Award for 1988, South Atlantic Division. He is a registered professional engineer in the State of Florida.

DR. DONALD K. STAUBLE

Dr. Stauble is a team leader of the Coastal Geology Unit, Coastal Structures and Evaluations Branch, Engineering Development Division, CERC, WES. The Coastal Geology Unit investigates geologic process and response changes to the coastlines of the United States. These studies encompass a broad range of research topics, including historic shoreline trends, beach nourishment technology, barrier island and other coastal sedimentation processes, coastal engineering geographic information system, and

remote sensing image analysis, the effect of sea level rise, and general research into coastal geomorphic and geologic problems pertinent to the Corps of Engineers.
Dr. Stauble earned his B.S. degree in geology from Temple University in 1969, his M.S. degree in oceanography from Florida State University in 1971, and his Ph.D. degree in marine/environmental science from the University of Virginia in 1979. Prior to working at CERC, he taught and conducted research for 9 years in the Department of Oceanography and Ocean Engineering at the Florida Institute of Technology. His research has been in the fields of beach nourishment technology; coastal processes; storm-induced beach changes; inlet, beach, shoal, and estuarine sediment transport and morphology; and coastal remote sensing. Dr. Stauble is a member of the Society of Economic Paleontologist and Mineralogist, American Shore and Beach Preservation Association, Florida Shore and Beach Preservation Association, American Society of Photogrammetry and Remote Sensing, American Geophysical Union, and the Marine Resources Council of East Central Florida. Dr. Stauble is a registered professional geologist in the State of Florida.

CHARLES F. STEVENS

Mr. Stevens is a civil engineer with the Coastal Section, Planning Division, SAJ. He graduated with a bachelor of technology degree in oceanographic technology from the Florida Institute of Technology in 1975. He received an M.S. degree in water resources engineering (coastal engineering) with an environmental systems engineering minor from Clemson University in South Carolina in 1976. He has been a coastal engineer and study manager in Planning Division since September 1977. He serves primarily as a study manager for the planning and design of Federal shore protection projects in Florida, Puerto Rico, and the US Virgin Islands. He assisted in the engineering and design of the protective measures being constructed for the San Juan National Historic site (El Morro fortress) in San Juan, Puerto Rico. He is the study manager for the Coast of Florida Study, the largest coastal study undertaken by SAJ. He has been assistant Section Chief since 1983 and has been acting Section Chief since April 1990.

DR. C. LINWOOD VINCENT

Dr. Vincent is currently Senior Scientist and Program Manager for the CERC, WES. His positions in the past include Chief, Coastal Branch, Wave Dynamics Division, Hydraulics Laboratory, WES; Chief, Coastal Oceanography Branch, Research

Division, CERC, Fort Belvoir, Virginia; and Senior Scientist, Research Division, CERC, WES. Dr. Vincent's research interests include ocean wave mechanics, air-sea interaction, spectral wave modeling, and wave climatology. He has also worked in the area of tidal inlet processes. Dr. Vincent has received an Army Research and Development Achievement Award, the American Society of Civil Engineers Walter L. Huber Prize, for his wave research, and the Meritorious Civilian Service Award. He has written 80 reports and papers. Dr. Vincent has a B.A. degree in mathematics and M.S. and Ph.D. degrees in environmental sciences (earth sciences) from the University of Virginia.

APPENDIX B
STATUS OF ACTION ITEMS

CERB Action Items

ACTION ITEM	PLACE AND DATE OF ACTION	RESPONSIBLE AGENT	ACTION AND STATUS
52-1. Report on restrictions on foreign travel by CERC staff members and on foreign visitors to CERC, and effects on tech transfer into the United States.	Redondo Beach Oct 89	CERC CERD	Policies restricting foreign travel by CERC staff are not expected to change. Corps has not been able to convince Army to reduce requirements for foreign visitors.
52-2. Explore mechanisms for increasing CERC's ability to obtain maximum benefits from foreign research.	Redondo Beach Oct 89	CERC	CERC uses various means for doing this. However, Army regulations have required curtailing some informal agreements. Corps' European liaison is being used to increase contacts, and OMNET/Telenet is being used.
52-3. Include a presentation on Oceanside, CA, sand bypass system at this meeting.	Redondo Beach Oct 89	CERC	Presentation on agenda.
52-4. Investigate approaches to increase CERC publication in refereed journals.	Redondo Beach Oct 89	CERC	Investigation shows further incentives are not needed.
52-5. Investigate whether R&D expenditures on breakwaters are commensurate with Corps costs in breakwater construction and maintenance.	Redondo Beach Oct 89	CERC	Guidance from technical monitors and Field Review Group is that expenditure level is appropriate.
52-6. Investigate a Corps program to address catastrophic events.	Redondo Beach Oct 89	CERC CERD	Possibilities discussed with Pacific Ocean Districts on training District personnel on making measurements.
52-7. Look into sabbaticals for CERC staff.	Redondo Beach Oct 89	CERC	Question will be pursued through DOD Laboratory Demonstration Program.
52-8. Investigate a program for foreign nationals to work at CERC.	Redondo Beach Oct 89	CERC	Issue is extremely complex. Changes required from top levels of DOD, OPM, and Congress.

51-5. Publish John Housley's results from the follow-up studies on low-cost shore protection.	Wilmington May 89	CECW-P	Report has been printed.
51-7. Determine whether National Oceanic and Atmospheric Administration or Minerals Management Service (MMS) is mapping coastal sand resources. If not, should Corps establish a program to map the resources.	Wilmington May 89	CERC CERD	US Geological Survey and MMS contacted. MMS has interest in more dialogue with the Corps.
51-8. Review establishment of Science and Technology Research Center (STRC).	Wilmington May 89	CERC	Proposed STRC not selected for funding.
51-9. Include a discussion on determining coastal project benefits at the Florida meeting in May 1990.	Wilmington May 89	CERC	Panel Discussion scheduled.
51-10. Get coastal engineering added to SKAP categories other than R&D.	Wilmington May 89	CECW-P	Adding to categories outside R&D could be detrimental. Broader issue remains that Coastal Engineer is not OPM classification system.
50-12. Explore potential for sharing with coastal states, Corps' execution of its coastal R&D responsibilities.	Virginia Beach Nov 88	CERD CERC	Revised draft cooperative agreement with California forwarded to HQUSACE for final approval. Will serve as a model for discussions with seven other states.

APPENDIX C

REGULATIONS RELATING TO FOREIGN VISITS

Visits

From AR 380-10, Disclosure of Information and Visits and Accreditation of Foreign Nationals.

5-1. Visit authorization

a. An official Request for Visit Authorization (RVA) is required for any interaction (except activities described in para 5-2) between foreign representatives and DA organizations, facilities, or contractors or nongovernmental associations under DA security cognizance. The military attache of the sponsoring foreign government will prepare the RVA. All RVAs will be submitted to and approved by ODCSINT, DA, except as specifically authorized by this regulation....

b. RVAs received by ODCSINT less than 30 calendar days prior to the proposed visit date may be returned without action. This prior notice is established by DOD and applied uniformly to all foreign governments. It is based on reciprocity and the need for coordination and preparation...

From Memorandum "Correction to Security Update # 3-88", CORPS DAENPM

....There are occasions, however, when foreign representatives or colleagues may visit unexpectedly, and to turn them away without display of expected civility would be counterproductive. In this regard, the following guidance is provided:

The Technology Transfer Division, Office of the Deputy Chief of Staff for Intelligence, has no objection to an installation commander extending the usual courtesies, e.g. coffee and "small talk". to foreign colleagues who may visit unexpectedly. If at anytime, however, foreign nationals attempt to discuss professional matters during these visits, they must be advised of the prohibition against such discussions...

....Attempts to end-run the intent of these rules by meeting foreign visitors off installation to discuss professional matters of to exchange information would be viewed with alarm by this office, and could warrant investigation or inquiry.

Information and Personnel Exchange

From AR 70-41

These exchanges are conducted as prescribed in AR 34-1, AR 70-23, AR 70-58, AR 70-66, or AR 614-10, as appropriate. For example, discussions during bilateral staff talks may result in data exchange annex under AR 70-33. Whereas discussions held on NATO RSI might result in an exchange of personnel under AR 34-1. Information or personnel exchange should be conducted under established programs of MOUs to cut down on the number of authorization documents.

So the Army may be aware of prospective international R&D agreements and help prevent duplication and unneeded proliferation, these preliminary discussions must be reported to DARCOM before any binding commitments are made by US Army representatives. Consequently, any US Army developing agency conducting or intending to conduct discussions with a foreign government about

producing an MOU or other agreement on Cooperative R&D will provide the following information to DARCOM, DRCIRD-C:

(1) Subject of proposed agreement
(2) Foreign country involved
(3) US Army developing agency
(4) Type of proposed cooperative agreement
(5) Point of contact

This information must be provide as soon as possible following initial discussion with the foreign government representatives.

To meet the requirements of these three documents, all US Army MOUs pertaining to international cooperative R&D activities must be submitted in draft form to DARCOM for review, staffing, and approval prior to their negotiation and conclusion.... Allow 60 to 90 days for complete DARCOM, DA, and OSD staffing and approval.

...negotiations are best conducted by negotiating team. This team ideally consists of administrative, legal, and technical representatives.... Each US Army R&D agency anticipating involvement in negotiating a cooperative R&D MOU with another country will request a representative from DARCOM DRCIRD to take place in prospective negotiations.

APPENDIX D

OVERVIEW OF THE US ARMY CORPS OF ENGINEERS WETLANDS RESEARCH PROGRAM

30 March 1990

FACT SHEET

U.S. ARMY CORPS OF ENGINEERS WETLANDS RESEARCH PROGRAM

Background. The U.S. Army Corps of Engineers (USACE) is required to evaluate and minimize environmental impacts of water resource projects associated with its construction, operation and maintenance, dredging, environmental planning, and natural resource management activities. Wetland restoration and development to replace lost or impacted wetlands, including wetland stewardship and management, are often a part of USACE activities. The USACE must consider all functions and values of wetlands, negative impacts in wetlands, and cumulative or regional effects through impacts from wetlands modification or management. Program Manager is Mr. Russell F. Theriot, 601/634-2733.

Objectives. To develop and carry out a broad USACE Wetlands Research Program (WRP) that encompasses a thorough knowledge of wetlands, restoration and development, minimization of wetlands impacts, assessment techniques for regional or cumulative changes in wetlands, stewardship and management, and the status and evaluation of wetlands. The WRP will devote significant efforts toward useful and widely-disseminated technology transfer. Accomplishment of objectives will result in improvement of existing U.S. wetlands, reduction of wetlands losses and impacts, and better environmental accountability in water resource projects.

Task Area I: Interagency Coordination and Cooperation. Interagency coordination, cooperation, and communication are extremely important aspects of the WRP. Opportunities for exchanging information and cooperative wetlands work efforts will be explored at both a regional and national level. (Mr. Richard Coleman, Assistant Program Manager, 601/634-2569).

Task Area II: Technology and Information Transfer. Technology and information transfer will be a key focus of the WRP, and will provide the mechanism for disseminating information from all eight Task Areas to USACE offices, other Federal, state, and regional agencies, academia, private organizations, and the public at large. (Mr. Thomas R. Patin, Technical Coordinator, 601/634-3444).

Task Area III: Critical Processes of Wetlands. An understanding of critical wetland processes is vital to effective restoration, development, and management of existing and proposed wetlands. Work Areas being developed are: (1) hydrology, (2) sedimentation, (3) soil, (4) role of wetlands biota, and (5) water quality. (Mr. Bruce A. Ebersole, Technical Coordinator, 601/634-3209).

Task Area IV: Delineation and Evaluation of Wetlands. All projects associated with wetland areas require decisions regarding delineation of wetland boundaries and assessment of functions and values of wetlands. Three Work Areas will be addressed: (1) delineation (hydric soils, hydrophytic vegetation, and hydrology); (2) evaluation of functions and values (refine WET, regional and local importance); and

(3) related technology improvements. (Mr. Ellis J. Clairain Jr., Technical Coordinator, 601/634-3774).

Task Area V: Restoration and Development of Wetlands. The USACE has restored, built, or enhanced numerous wetlands sites. A variety of engineering and environmental techniques have been developed and tested. However, there are areas where the knowledge base is not fully adequate to address restoration or development of certain wetland types. USACE offices and their permit applicants are in immediate need of written scientific and engineering guidelines and procedures for wetlands restoration and construction. To accomplish the broad range of work within this Task Area, four Work Areas will be developed: (1) improved design criteria (hydrology for selected wetland types, soils transfer and placement, baseline vegetation criteria for establishment and maintenance, and engineering procedures and construction techniques); (2) development of standard monitoring and success criteria; (3) techniques for ensuring success of restored or developed wetlands; and (4) wetland demonstration and/or evaluation projects with full interagency cooperation and coordination. (Dr. Mary C. Landin, Technical Coordinator, 601/634-2942).

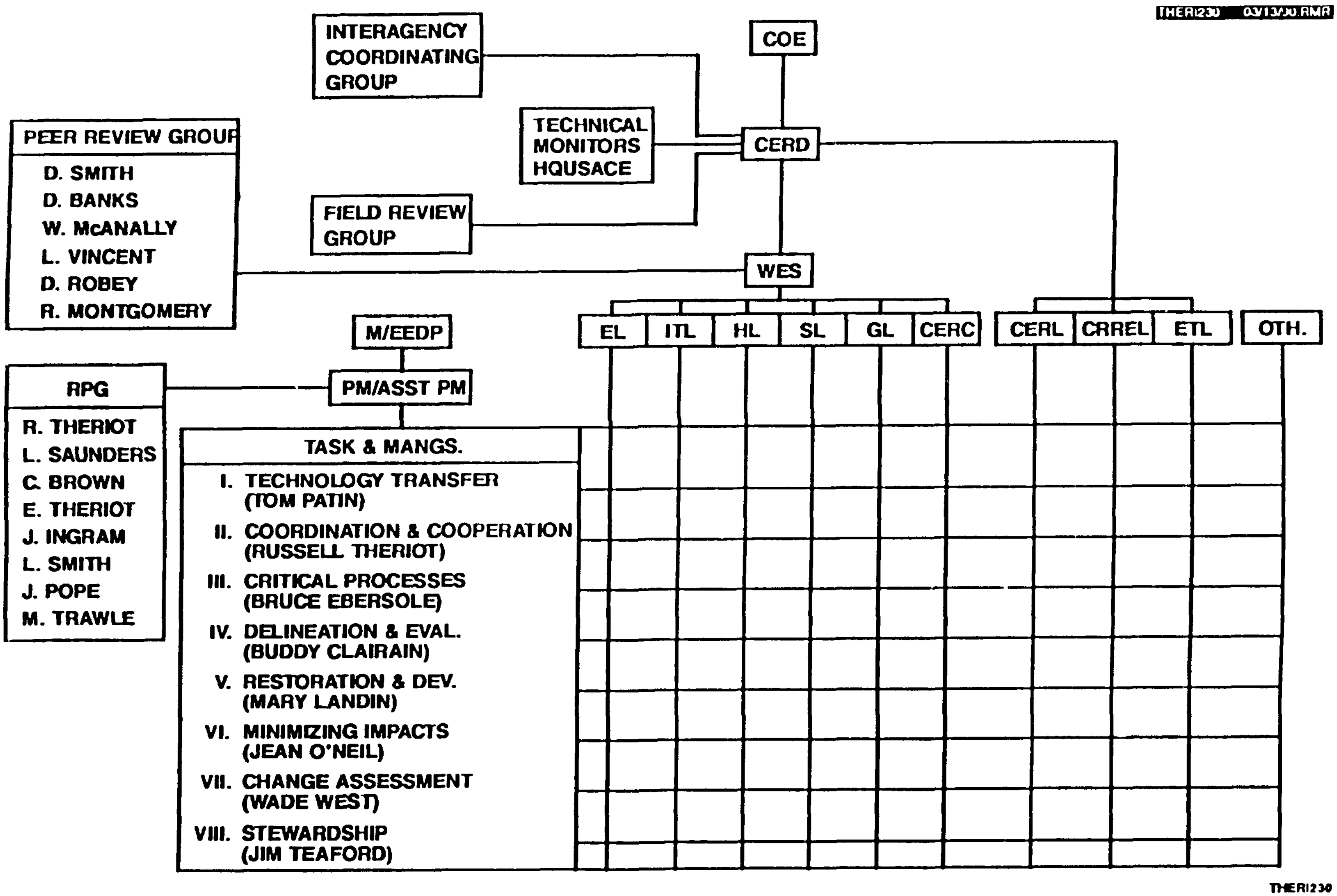
Task Area VI: Predicting and Minimizing Impacts in Wetlands. Adequate information, predictive tools, and standardized procedures are not currently available to assess wetlands short-term and cumulative impacts. Impact recognition and minimization techniques need to be developed which cover the range of wetland types. Work Areas include: (1) identification and characterization of activities impacting wetlands; (2) methods to predict impacts; (3) cumulative impact analysis; and (4) engineering techniques to minimize impacts. (Ms. Jean H. O'Neil, Technical Coordinator, 601/634-3641).

Task Area VII: Wetlands Change Assessment. Although significant work has been accomplished in developing techniques for identifying wetland systems, new criteria and methodologies are needed which focus specifically on economically monitoring the physical and biological status of large areas already identified as wetlands. Four Work Areas will address: (1) appropriate parameters for assessing wetlands changes; (2) remote sensing data from sensor systems; (3) determining field measurements for assessment; and (4) systems for wetland analysis, mapping, and data management. (Mr. Wade West, Technical Coordinator, 601/634-2232).

Task Area VIII: Stewardship and Management of USACE-Controlled Wetlands. The USACE owns or controls nearly 9,000,000 acres of land managed for natural resources; much of this land involves water resources (reservoirs, lakes, rivers, wetlands). Work Areas to be addressed include: (1) wetlands inventory and evaluation procedures and information system; (2) identification and assessment of management technology; and (3) stewardship and management demonstration wetlands. (Mr. James W. Teaford, Technical Coordinator, 601/634-2370).

Program Cost Estimate. $22,000,000

Program Time Frame. FY 91 - FY 93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R. THERIOT
L. SAUNDERS
C. BROWN
E. THERIOT
J. INGRAM
L. SMITH
J. POPE
M. TRAWLE
PM/ASST PM
TASK & MANGS.
I. TECHNOLOGY TRANSFER (TOM PATIN)
II. COORDINATION & COOPERATION (RUSSELL THERIOT)
III. CRITICAL PROCESSES (BRUCE EBERSOLE)
IV. DELINEATION & EVAL. (BUDDY CLAIRAIN)
V. RESTORATION & DEV. (MARY LANDIN)
VI. MINIMIZING IMPACTS (JEAN O'NEIL)
VII. CHANGE ASSESSMENT (WADE WEST)
VIII. STEWARDSHIP (JIM TEAFORD)
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APPENDIX E
BOARD RECOMMENDATION LETTERS

CALIFORNIA INSTITUTE OF TECHNOLOGY
W. M. KECK LABORATORY
OF
HYDRAULICS AND WATER RESOURCES 138-78

June 11, 1990

Major General Patrick J. Kelly
Director of Civil Works
U.S. Army Corps of Engineers
20 Massachusetts Avenue, Northwest
Washington, D.C. 20314-1000

Dear General Kelly:

I just wanted to review with you some of the comments I made near the end of the recent CERB meeting in Ft. Lauderdale and to respond to some of the questions you raised at the breakfast meeting on Wednesday. The thrust of several of these comments was with regard to future CERB meetings.

In the first instance, I thought that considering the interest that the Corps of Engineers has in wetland preservation I felt that it would be appropriate at the meeting in Louisiana in October for a representative of the Corps to discuss wnat the Corps is doing (both policy and study) with regard to coastal wetland conservation. I wanted to be sure that this was not overlooked in the plans that the Corps has for general wetlands environmental concerns.

In noticing that the subject of one of the future CERB meetings (October 1991 - tentative) was coastal structures, I would suggest that there be an in-depth discussion at that meeting of the problem of the rehabilitation of "aging" coastal structures. As we move into the last decade of the century, it is apparent to me that many of our coastal structures will have aged to the point that a major rehabilitation program may be necessary. In a sense, the rehabilitation of structures such as breakwater, jetties, etc. is inherently more difficult than constructing new facilities at our coastline. For these reasons, I believe it is important to discuss the possible extent of the U.S. needs along these lines and the plans that the Corps has for approaching this important problem.

As I think each of the CERB members has expressed at one time or another, I too feel that it is extremely important for CERC staff to participate actively in foreign meetings and to be able to travel to foreign laboratories. At least the importance of one element which was a reason to limit this, i.e. the problems associated with Eastern bloc nations, has been reduced. I don't believe we can expect CERC to be considered by our foreign colleagues as a top flight national laboratory when, for example, its director is not able to travel to the forthcoming International Conference on Coastal Engineering to be held in Delft, The Netherlands, in the early part of July. I realize this is a continuing problem, perhaps without an immediate solution, but I feel that any effort that the Corps can make along these lines would be quite beneficial in the long run.

PASADENA, CALIFORNIA 91125 (818)356-4403

My final comment at the meeting related to the need for a large, three-dimensional wave facility at CERC. This facility should be large enough to be able to handle large-scale physical models in three-dimensional testing and be able to be partitioned to create a large two-dimensional wave flume in one part of it. I would think a spectral wave generator similar to, but larger than, the present one at CERC would be appropriate for such a facility. This would provide a facility to conduct three-dimensional stability tests of coastal structures such as breakwaters, jetties, etc., and for study of three-dimensional sediment transport, thereby reducing the importance of scale effects in going from laboratory results to the prototype. There is always a need to validate numerical models, and the process of validation is extremely complicated when one uses field measurements alone. Of course, the use of field measurements is the final validation. However, to facilitate the development of such models and to insure that they are being developed in the correct way, laboratory tests in such a large-scale facility would be invaluable. I understand from our initial briefing at CERC that in a sense the laboratory borrows money for construction of facilities and then pays back through reimbursable funds at a given rate. However, I am not suggesting this as a means of developing funds for such a facility. I believe funds should be developed specifically for this facility as a separate line item in CERC's budget without this "mortgage" plan along with funds for supporting equipment.

There are other comments which I would like to add which were not made at the meeting itself. I like the theme presentations which I have seen now at two of the CERB meetings. However, I believe it would be useful, certainly to the CERB members, for the presentations (especially by CERC personnel) to have a little more technical content. Too many times it appears that the presenters are showing slides with such general information that it is difficult for us to determine the substance of what is being presented. I think this can be done without boring us with a lot of detail, and I think it would improve the contributions that can be made by the civilian CERB members.

Since there are many different topics which are presented with regard to the meeting theme, it might be appropriate for the presenter or someone connected with the specific topic to discuss the policy matters and issues to which the Corps is faced with regard to the various topics. This would allow us to put some of these topics into perspective along with the technical accomplishments.

Your suggestion of reserving some time for discussion among the Board members, I believe, is quite valuable. At the two CERB meetings that I have attended, a group of us have had dinner on the night before the last session generally discussing the meeting and some of the issues that we civilian CERB members have seen arise at the meetings as well as thoughts we have had prior to the meetings. The chance to air and discuss these first, before the final wrap-up session, I have found quite useful.

I have heard two presentations now related to the DRP, neither of them being anywhere near complete in my mind. I believe that there is a significant contribution being made by the Hydraulics Laboratory at WES to the DRP with regard to the dispersion and movement of dredged sediment which might be somewhat different from the approaches of CERC. I would like to be informed more regarding the interaction between the two groups and specifically the accomplishments to date. The appropriate place to do this would be at the spring 1991 meeting, although perhaps at the next meeting a general outline of the contribution of the Hydraulics Laboratory to the DRP could be presented.

Finally, I would like to applaud the new Demonstration Laboratory Initiative which the Corps has embarked on. This is just the type of thing I believe the civilians CERB members have spoken about, i.e., the need for basic research studies conducted at CERC. This provides a mechanism for CERC personnel to broaden their perspectives and use some of the superb facilities at CERC for research which is less applied than that in which they are usually involved.

Although I have only attended two meetings, I certainly have found both of them to be stimulating, interesting, and educational. I look forward to future meetings and the possibility of making some contribution to the effort of the Corps of Engineers in the Coastal Engineering area.

Sincerely,

Fredric Raichlen

FR:fm

Texas A&M University
Department of Oceanography
College Station, Texas 77843

June 12, 1990

Major General Patrick J. Kelly
Director of Civil Works
U.S. Army Corps of Engineers
20 Massachusetts Ave, N.W.
Washington, D.C. 20314-1000

Dear General Kelly:

As a follow-up of the recent meeting of CERB at Ft. Lauderdale you asked for some thoughts from the Board members as to the focus of the Dredging Research Program.

Clearly the relevance and potential impact of this program in terms of its major objective of reducing costs of dredging operations for navigational channels and possible spin-off benefits for beach nourishment is such as to make it a very high priority program. It is therefore essential that the several tasks within this program retain a focus which will assure the achievement of its very important goal. My understanding is that these tasks include: improvement in operational techniques and equipment technology; improvement in our means of characterizing the geotechnical properties of sediments; research pertinent to predicting the fate of disposed material; improvement in the means of accurately determining the depth to which material is removed in dredging project areas, which requires accurate real time determination of tide level in the area concerned; and managerial/contractual aspects which can improve the efficiency of dredging project operations.

A related topic which has received some discussion in previous meetings of the Board is the possibility of using good quality dredged sediments for nourishment of adjacent beach areas. It seems to me that such an option could result in cost benefits in the overall coastal mission of the Corps of Engineers.

My impression from the brief updates on DRP which have been presented to the Board in its last three meetings is that the DRP seems to be on target in respect to the tasks discussed in depth at the special meeting held in Washington, D.C., in February of 1989. However you may wish to hold another special meeting devoted exclusively to DRP early in 1991 to review its progress, particularly in view of the turn over in Board members since the special meeting of February 1989.

Sincerely,

Bob Reid

Robert O. Reid
Professor of Oceanography

ROR/rsc

cc: Col. Larry Fulton
Prof. Tony Dalrymple
Prof. Fred Raichlen
Dr. James Houston

CENTER FOR APPLIED COASTAL RESEARCH

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June 23, 1990

Major General Patrick J. Kelly
Director of Civil Works
U.S. Army Corps of Engineers
20 Massachusetts Avenue, N.W.
Washington, D.C. 20314-1000

Dear General Kelly:

After listening to the presentations at the last Coastal Engineering Research Board meeting in Fort Lauderdale this month concerning tidal inlets and based on my own and other's experiences, it is clear that inlets are traps for sand moving along coastlines and are major causes of shoreline erosion in the U.S.

In the absence of an inlet, the natural littoral processes move sand along a beach. By interrupting this alongshore transport with an inlet, the sand is deposited into flood and ebb tidal shoals by the tidal currents coursing through the inlet, often resulting in significant erosion problems on downdrift shorelines. For example, the presentation by Prof. Dean shows that 80% of all shoreline erosion in Florida can be attributed to the presence of inlets. The sand lost to the beaches due to these inlets is either contained in tidal shoals or disposed offshore by maintenance dredging of channels.

I offer the following three recommendations concerning Corps of Engineers policies:

1. Offshore disposal of beach quality sand dredged from navigational channels must stop and justifications must be found for the placement of this sand on nearby eroding shorelines. The coast is too valuable in most locales to permit continued erosion, exacerbated by the removal of sand from the littoral system by the Corps of Engineers.

2. All inlets maintained by the Corps of Engineers on sandy shorelines should be assessed for downdrift erosion problems and present sand bypassing (natural and artificial) should be evaluated for efficacy. Serious downdrift erosion problems due to the presence of an inlet should be remedied as soon as possible through permanent bypass solutions.

3. Any new inlet or harbor construction should have demonstrably workable sand bypassing schemes incorporated into the design.

It is reassuring that workable bypass solutions do exist. The sand bypass plant at Indian River Inlet, DE, built by the Philadelphia District, has shown in the past few months that innovative but relatively low cost and low technology means do exist to bypass sand at inlets.

Sincerely yours,

Robert A. Dalrymple
Professor and Director